1990

Cognitive Components Of Naming In Children: Effects Of Referential Uncertainty And Stimulus Realism

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COGNITIVE COMPONENTS OF NAMING IN CHILDREN:

EFFECTS OF REFERENTIAL UNCERTAINTY AND STIMULUS REALISM

by

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Submitted in partial fulfilment
of the requirements for the degree of
Doctor of Philosophy

Faculty of Graduate Studies
The University of Western Ontario
London, Ontario
May, 1990

ISBN 0-315-59083-1

ABSTRACT

The purpose of this research was to identify stimulus characteristics that influence the ease of picture naming in children. Naming is a basic aspect of language behavior that includes such components as object identification, selection of an appropriate name, and generation of the naming response. Little is known about factors that influence the proficiency with which these components are executed. This research attempted to isolate the effects on naming efficiency of: (a) the number of available correct names for a picture (referential uncertainty) and (b) the degree to which a picture realistically represents the depicted object (stimulus realism).

Results from three experiments demonstrated that: (a) objects with several acceptable names (high uncertainty) were named more slowly than those with a single dominant name (low uncertainty), and (b) this effect arose at a post-identification phase of naming. In Experiment 1, 120 children (ages 4;5 to 7;8) made naming or object decision responses to pictures that varied in referential uncertainty. Uncertainty influenced naming but not object decision reaction times, suggesting that it affected a post-identification phase of processing unique to naming. Experiment 3 replicated this effect of uncertainty on naming using the same stimuli with another sample of 72 children (ages 6;7 to 8;6). Experiment 2 employed an experimental manipulation of uncertainty. Children (48 Ss, ages 6;11 to 8;6) learned novel names for two unfamiliar objects, one paired with a single name (low uncertainty), the other paired with two names (high uncertainty). Again, naming times for high uncertainty objects exceeded those for low uncertainty objects. Possible mechanisms for the uncertainty effect include passive diffusion

of activation over multiple object-name pathways or active inhibition among competing candidate names.

The experiments also assessed the effects on naming of stimulus realism. In each experiment, subjects responded to both realistic (colored photographs) and abstract (uncolored line drawings) pictures of the same objects. No conclusive evidence emerged for an effect of stimulus realism on naming.

The results demonstrate that the availability of several possible names for an object increases the difficulty of a post-identification phase of naming. Future research should determine the underlying mechanism responsible for this uncertainty effect.

ACKNOWLEDGEMENTS

I am grateful to the many people who helped me to complete this project. It is a pleasure to acknowledge their contributions.

First, I would like to thank my advisor, Allan Paivio, for his support throughout my graduate studies and particularly during this research. He has challenged me consistently with thoughtful comments and provocative questions. Thanks are also due to the members of my advisory committee, Stephen Lupker, Marc Fey, and Michael Pressley, who contributed important suggestions and insights to this thesis.

A special thanks goes to R. G. Stennett and to the London Board of Education for providing access to the subjects for this research. I very much appreciated the willing cooperation shown by the principals, teachers, parents, and children who participated.

I am also indebted to friends who volunteered their time and expertise. I thank those who served as judges or raters for the various norming studies. In addition, thanks are extended to: Suzanne Michels for subject recruitment; Bob Michels and Trudy Bons for computer assistance; Bob Gardner for statistical advice; Jim Clark for thoughtful criticism; and Jim Stouffer for unfailing moral support. I also appreciated the encouragement that was offered consistently by my family and close friends.

Finally, I gratefully acknowledge the financial support that was provided by a Graduate Studies Fellowship from the Health Research Personnel Development Program of the Ontario Ministry of Health. The opinions expressed herein are my own, however, and no official endorsement by the Ministry is intended or should be inferred.

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INTRODUCTION

Object identification, name selection, and response generation are important cognitive components of the naming operation. Yet, little is known about factors that selectively influence the proficiency with which these components of naming are executed. The questions posed in this research concern the selective effects of two factors, referential uncertainty and stimulus realism, on children's naming of pictured objects. The answers to these questions extend our knowledge of naming behavior and of the normal course of semantic memory development.

The introduction to this research begins with brief remarks concerning the nature and importance of naming. Next, current cognitive models of naming are described. A literature review then focusses on task conditions, subject characteristics, and item attributes known to affect the naming of single pictured objects. A summary of relevant theoretical issues introduces the experiments.

Nature and Importance of Naming

Naming is the fundamental human ability that permits us to communicate our thoughts via language (Terrace, 1985). The act of referring with names is so commonplace that we often fail to appreciate its complexity and importance. Yet, the study of naming and reference raises issues central to philosophy, linguistics, and psychology (Brown, 1976; Macnamara, 1982). What is the nature of meaning (Putnam, 1975; Quine, 1960)? What is the relation between thought and language (Olson, 1970; Whorf, 1956)? Are grammatical classes based on earlier semantic classes (Maratsos & Chalkley, 1980; Bates & MacWhinney, 1982)? What are the social and cognitive antecedents of naming (Bates, 1979; Gopnik & Meltzoff, 1986; Ninio & Bruner, 1978)? What, if any, innate dispositions does the child bring to the language learning task (Macnamara, 1982)? How does the child acquire the ability to refer by observing the language use of others (Bridges, 1986)? When, and how, does truly symbolic representational naming emerge (Bloom, 1973)? Are members of non-human species capable of symbolic reference (Savage-Rumbaugh, McDonald, Sevcik, Hopkins, & Rubert, 1986; Terrace, 1985)? What does naming behavior, in conjunction with other evidence, reveal about the working, organization, and development of semantic memory (Anglin, 1977; Nelson, 1978, 1985, 1986; Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976)? These critical questions place the study of naming at the "core of cognitive psychology" (Macnamara, 1982, p. viii).

The naming of objects generally is viewed as the paradigm case of reference, although we also name actions, attributes, and relations. Naming an object is a seemingly simple act. Yet, the underlying cognitive processes are far from simple. Initially, the visual system must recognize an individual object as distinct from a complex and changing environmental background. The object must be reliably identified as a member of a particular class of objects, despite extreme differences in its appearance and spatial orientation across situations. An appropriate name must then be selected and produced, from among the literally thousands of words that are known to language users. All of these operations must occur at a speed that permits conversational exchange at a rapid rate.

The complexity of naturally-occurring object naming behavior has led psychologists to look for a laboratory task that permits the study of naming under simplified conditions that are amenable to careful experimental control. The naming of pictured objects meets these requirements for a reasonable laboratory analogue to natural naming and, consequently, has been used extensively as an experimental paradigm (Lachman & Lachman, 1980).

Moreover, picture naming is a topic of interest in its own right. Information is often communicated in pictures, either alone or in conjunction with written text. Instructional materials are based on the assumption that young children can identify and name pictures readily. In educational and clinical settings, major diagnostic and intervention decisions often are based on the results of tests involving the identification, naming, or description of pictures (Anastasi, 1982; Wiig & Semel, 1984). In particular, picture naming tasks appear to be sensitive indicators of a variety of neurological and developmental disabilities (see below). Thus, continued study of the cognitive processes involved in picture naming appears likely to inform a variety of theoretical and practical issues.

Cognitive Models of Naming

Current cognitive models of object/picture naming behavior (Clark & Clark, 1977; Huttenlocher & Kubicek, 1983; Lachman, 1973b; Lachman & Lachman, 1980; Paivio, 1971, 1986; Potter & Faulconer, 1975; Seymour, 1973, 1976; Snodgrass, 1984; Theios & Amrhein, 1989; Wolf, 1982) generally postulate at least three broad phases: perceptual identification, name access, and response generation (Paivio, Clark, Digdon, & Bons, 1989). Identification of the stimulus object/picture leads to activation of one or more candidate names and, eventually, to selection and production of one of the candidates as an overt naming response. The assumption that perceptual processing precedes name access is supported by research showing that physical identity judgements are reliably faster than name identity judgements for the same pictures (Bisanz, Danner, & Resnick, 1979; Hoving, Morin, & Konick, 1974; Tversky, 1979). The three naming phases often are assumed to occur in a roughly sequential manner, but need not be entirely serial in that processing for the next phase may be initiated before the preceding phase is finished (i.e., name access may begin before object identification is fully completed) (Lachman & Lachman, 1980).

Despite the general agreement concerning the broad phases of the naming operation, cognitive models differ in the nature and explicitness of their assumptions concerning representational structure and function. The dual coding theory account of naming (Paivio, 1971, 1986), which provides the theoretical framework for the present research, incorporates explicit structural as well as functional assumptions. At the most general level, dual coding theory assumes the existence of two independent, but interconnected, representational subsystems. The nonverbal subsystem is specialized for processing nonlinguistic information, whereas the verbal subsystem is specialized for processing language. Representational units within each subsystem are termed imagens (Paivio, 1986) and logogens (Morton, 1969, 1979), respectively. Both imagens and logogens accumulate modality-specific information until the recognition threshold for a particular nonverbal or verbal stimulus is reached. Representational units within each subsystem are associatively interconnected. In addition, referential connections exist between subsystems. An imagen corresponding to a concrete object is connected in a one-to-many fashion to logogens corresponding to its names. Likewise, a logogen corresponding to a particular word may have referential connections to a number of different imagens. The strength and number of referential connections are determined by experience with the relevant objects and their names. These referential connections permit bidirectional mental translation between the two representational subsystems. The naming of objects or pictures requires referential translation in the nonverbal to verbal direction, whereas imaging to words involves translation in the opposite (verbal to nonverbal) direction.

During naming, the stimulus object/picture initiates representational activity within the nonverbal subsystem. An imaginal representation (imagen) corresponding to the depicted object is aroused. Activation then spreads (e.g., Anderson, 1983; Collins & Loftus, 1975) from the imagen via its referential connections to associated logogens (names) in the verbal representational system. Activation to one of the logogens eventually exceeds its threshold, thereby initiating the production of that name as a response.

Despite the intuitive appeal of cognitive models that describe naming as a three-phase operation, readers should keep in mind a number of qualifications. First, as mentioned earlier, the phases are not necessarily discrete. As a result, it has proven challenging to devise experiments that isolate a particular phase of the naming operation. Second, the models describe naming at a particular level of generality. Presumably, there are other fine-grained cognitive processes that occur within each phase. Third, for models of naming as well as for cognitive models in general, it is difficult in principle to reliably distinguish representational structure from function (Anderson, 1978; Paivio, 1986). Thus, assumptions and inferences regarding cognitive representations and processes need to be evaluated with respect to their plausibility and ability to account for empirical data.

In attempting to infer the representational structures and processes underlying picture naming, researchers have relied on naming accuracy, latency, and error patterns as their principal dependent measures. The three measures, although interrelated, reveal different aspects of the naming operation. In particular, reaction time (RT) measures are assumed to provide a sensitive index of subtle differences in the difficulty of the cognitive processes underlying naming.

Variables Affecting Naming Accuracy and Speed

Most picture naming research has focussed on independent variables in the three broad categories of subject characteristics, task conditions, and item attributes. Empirical findings concerning these variables are summarized below.

Subject Characteristics

Age

With age, children's naming of pictures becomes more proficient, as reflected in faster latencies and closer approximation to adult levels of accuracy (Clark & Johnson, 1989; Denckla & Rudel, 1974; Fried-Oken, 1984; German, 1986; Wiegel-Crump & Dennis, 1986). Changes in the nature and relative distribution of naming errors also accompany development (Clark & Johnson, 1989; Fried-Oken, 1984; Rochford & Williams, 1962; Wiegel-Crump & Dennis, 1986; Wiig & Becker-Caplan, 1984), with naming omissions declining in favor of correct names and errors that are semantically related to the target. These changes appear to reflect the gradual, developmental accumulation and organization of both nonlinguistic and linguistic knowledge.

At the other end of the lifespan, the normal aging process may result in slower and/or less accurate naming (Albert, Heller, & Milberg, 1988; Butterfield & Butterfield, 1977; Mitchell, 1989; Thomas, Fozard, & Waugh, 1977), but differences in education and other cohort effects may be at least partly responsible for some of these findings (Poon & Fozard, 1978).

Gender

Gender effects are not reported regularly in the adult naming literature, but it is not clear whether this absence indicates that there are no reliable gender differences or merely that this variable has not been of interest to researchers.

There is a small amount of mixed evidence concerning gender effects on children's naming performance. Several studies found boys to be more accurate than girls in naming pictures (Kindlon & Garrison, 1984; Rudel, Denckla, Broman, & Hirsch, 1980) but the reverse has also been reported (Wiegel-Crump & Dennis, 1986). In the latter two studies, as well as one by Denckla and Rudel (1974), girls named pictures more quickly than boys.

Neurological Impairment

Naming impairment is a prominent characteristic of all clinical subtypes of aphasia, but especially so in anomia (Buckingham, 1981; Caplan, 1987; Carramazza & Berndt, 1978; Geschwind, 1967; Horner, 1986). One manifestation of this impairment is slow, inaccurate naming of pictured objects (Newcombe, Oldfield, & Wingfield, 1965; Newcombe, Oldfield, Ratcliff, & Wingfield, 1971; Rochford & Williams, 1962, 1963, 1965). Among various pictured stimuli, the order of naming difficulty for aphasics generally parallels that for normal children and adults (Rochford & Williams, 1962, 1963; Newcombe et al., 1965), but factors that increase naming difficulty for normal subjects (see section on item attributes below) may be especially problematic for aphasics (Mills, Knox, Juola, & Salmon, 1979; Newcombe et al., 1965). The majority of aphasic naming errors, like those of normal children and adults, are semantically related to the target name (Kohn & Goodglass, 1985; Rinnert & Whitaker, 1973; Williams & Canter, 1982; Williams & Wright, 1985). Unfortunately, it is not clear that all so-called semantic errors are of a similar origin. Because many semantically related names (e.g., apple/orange) have target objects that share perceptual features (Flores d'Arcais & Schreuder, 1987; Kelter, Grötzbach, Freiheit, Höhle, Wutzig, & Diesch, 1984; Snodgrass & McCullough, 1986), the production of a semantic error may reflect misidentification of the object and/or selection of an incorrect name.

Nonetheless, aphasic picture naming difficulties have most often been characterized as word retrieval (i.e., name access) problems that occur subsequent to correct perceptual identification of the target item. Both nonverbal and verbal representations are assumed to be grossly intact, but the target name is, for some reason, temporarily inaccessible. This characterization seems to be appropriate, at least in a broad sense, for many aphasic errors. Relatively intact nonlinguistic processing is often demonstrated by the aphasics' ability to pantomime or describe the appropriate use of the pictured object or match the picture to its corresponding object. In addition, patients are often able to recognize the spoken name and match it to the correct object, suggesting that the correct name is represented and mentally connected to the object representation (at least in the verbal to nonverbal direction). Access to the correct name can sometimes be facilitated by various semantic, syntactic, or phonemic cues (Barton, Maruszewski, & Urrea, 1969; Huntley, Pindzola, & Weidner, 1986; Rochford & Williams, 1962, 1963). Even when unable to produce the correct name, aphasics, like normals, demonstrate above-chance knowledge of general features of the name, such as its initial sound, length, and number of syllables (Barton, 1971).

Recently, however, aphasiologists have begun to question the traditional assumption of intact semantic representation in aphasia (Buckingham, 1981; Caplan, 1987; Caramazza & Berndt, 1978). The result has been an increasing realization that subtle perceptual differences may impact on the nature and efficiency of processing at the later name access phase. Increasingly sophisticated research techniques and hypotheses have revealed that naming is affected by subtle deficits in both nonlinguistic and linguistic representation and processing (Gainotti, Silveri, Villa, & Miceli, 1986; Huff, Mack, Mahlmann, & Greenberg, 1988; Koemeda-Lutz, Cohen, & Meier, 1987; Wayland & Taplin, 1982). This line of research may eventually enable a more precise discrimination of aphasic naming disruptions that arise at a perceptual identification phase from those that arise at subsequent phases of naming (e.g., Gainotti et al., 1986; Huff et al., 1988; Wayland & Taplin, 1982).

Naming deficits are not exclusively associated with aphasia. Naming also may be impaired by other neurological conditions such as dementia (Bayles, 1986; Huff et al., 1988; Rochford, 1971; Shuttleworth & Huber, 1988), right hemisphere lesions (Myers, 1986), and oxygen deprivation secondary to chronic cardiac conditions (Tweedy & Schulman, 1982). Children with brain lesions also demonstrate subtle, residual naming deficits (Aram, Ekelman, Rose, & Whitaker, 1985; Aram, Ekelman, & Whitaker, 1987).

Developmental Disorders

Naming difficulties are also associated with developmental language and/or learning disorders. Language impaired children name pictures more slowly and less accurately than their non-disabled peers (Fried-Oken, 1984; Kail & Leonard, 1986; Leonard, Nippold, Kail, & Hale, 1983; Wiig, Semel, & Nystrom, 1982; for a review see Wiig & Becker-Caplan, 1984). Because language impaired children comprise a significant proportion of children diagnosed as learning disabled (Wiig & Semel, 1984) and/or dyslexic (Mattis, French, & Rapin, 1975), it is not surprising that many learning disabled and/or dyslexic children also show naming deficits (Blumenthal, 1980; Denckla & Rudel, 1976a, 1976b; Denckla, Rudel, & Broman, 1981; German, 1979, 1982, 1984, 1985, 1986; Lewis & Kass, 1982; Murphy, Pollatsek, & Well, 1988; Rudel, Denckla, & Broman, 1981; Wolf, 1982, 1986; Wolf, Bally & Morris, 1986; Wolf & Goodglass, 1986). Of potential practical significance is the finding that early deficits in naming skills are strong predictors of eventual difficulties in learning to read (Jansky & DeHirsch, 1972; Wolf, 1982, 1986; Wolf et al., 1986; Wolf & Goodglass, 1986).

Most of the research conducted with developmentally impaired children has been designed to document an overall naming deficit rather than to reveal the source(s) of that deficit in terms of the three cognitive phases of naming. Nonetheless, the naming problems of developmentally disordered children, like those of aphasics, are often assumed to reflect retrieval difficulties. It is presumed that nonlinguistic representations and processes are intact because, by definition, children with specific language impairment, learning disabilities, and dyslexia have performance IQs within the normal range. Name words are assumed to be temporarily inaccessible when they cannot be produced in response to a picture. That these same words are nonetheless available is shown by their production in other situations, their facilitation by various types of cueing, and their comprehension (although this is too often assumed rather than assessed). A recent study of developmental dyslexics by Murphy et al. (1988) provides one of the few direct tests of the assumption that nonlinguistic processing is intact. Dyslexic children did not differ from their IQ-matched controls on measures of simple motor reaction time and picture categorization speed, but demonstrated significant deficits in naming, reading, expressive and receptive language tasks.

Other evidence, however, is consistent with the hypothesis that subtle perceptual and/or motor deficits contribute to the picture naming problems of developmentally disabled children. Although they did not initially favor such an explanation, Leonard et al. (1983) acknowledged that differences in the picture naming RTs of language impaired children and their age-matched controls could have resulted from differences in perceptual and/or motor processing. A later finding that language impaired children took longer than their age-matched controls to match physically identical pictures (Kail & Leonard, 1986, Experiment 3) also suggested the influence of perceptual and motor factors. In discussing the results of an extensive series of experiments, Kail and Leonard (1986) highlight the complexities involved in trying to distinguish storage (representation) versus retrieval (process) explanations of disordered naming performance (see Caplan, 1987, chap. 12 for a similar discussion with regard to aphasics).

In summary, then, the overall naming deficits of neurologically and developmentally impaired individuals are well-documented. Additional focussed research is required to determine whether these impairments are localized at a name access phase or may also arise at an earlier object identification phase.

Task Conditions

Pictures versus Other Naming Stimuli

A number of empirical generalizations emerge from comparisons of picture naming and related cognitive tasks, such as naming words, colors, numbers, or letters. For example, adults name (read) a word faster than they give the same word as a naming response to a picture (Fraisse, 1960, 1967, 1968, 1969; Irwin & Lupker, 1983; Jolicoeur, Gluck, & Kosslyn, 1984; Potter & Faulconer, 1975; Theios & Amrhein, 1989). Two factors appear to contribute to this difference. First, picture naming requires a nonverbal to verbal referential translation step not required in word-naming (Paivio, 1986). Second, words are consistently associated with a single response name, whereas pictures can be associated with several names (Fraisse, 1969; Theios & Amrhein, 1989). The stimulus-response mapping is, thus, less certain for pictures than words.

Differences in the certainty of the stimulus-name mapping have also been invoked to explain the finding that common objects are named more slowly than letters and/or numbers by school-aged children (Denckla & Rudel, 1974, 1976b; Morin & Forrin, 1965; Stanovich, 1981) and by adults (Morin, Konick, Troxell, & McPherson, 1965). Learning disabled (Denckla & Rudel, 1976b) and reading impaired children, as well as aphasic adults (Gardner, 1974) also find objects more difficult to name than letters or numbers. In terms of accuracy and latency, color naming is usually more similar to object naming than to letter or number naming.

Practice

Practice reliably reduces the naming RTs of normal and linguistically impaired adults and children (Bartram, 1973, 1974; Biederman & Cooper, 1989a, 1989b; Durso & Johnson, 1979; Fried-Oken, 1984; Lachman, Shaffer, & Hennrikus, 1974; Lachman & Lachman, 1980; Milianti & Cullinan, 1974; Mills et al., 1979; Mitchell & Brown, 1988; Rochford & Williams, 1963). Practice appears to influence all phases of the naming process. Maximal reduction in RT occurs when the same picture is renamed (Bartram, 1974; Lachman & Lachman, 1980) but a partial reduction in RT occurs for a different picture that requires the same name response (Bartram, 1974; Biederman & Cooper, 1989a, 1989b). Partial RT reductions also result from prior exposure to the picture (without naming) (Carroll, Byrne, & Kirsner, 1985; Lachman & Lachman, 1980; Warren & Morton, 1982) or prior production of the name-word (not in response to a picture) (Durso & Johnson, 1979; Lachman & Lachman, 1980; but see Warren & Morton, 1982, for a contrary result). The facilitation in naming latencies for previously named pictures is remarkably persistent, lasting for up to six weeks, even though, by then, many of the pictures are no longer recognized explicitly in a memory test (Mitchell & Brown, 1988).

Context

Naming of pictures can also be facilitated (primed) by prior presentation of semantically related information, such as a related word

(Carr, McCauley, Sperber, & Parmalee, 1982; Sperber, McCauley, Ragain, & Weil, 1979), a superordinate category name (Ceci, 1983; Kareev, 1982), a related picture (Carr et al., 1982; Flores d'Arcais & Schreuder, 1987; Henderson, Pollatsek, & Rayner, 1987; Huttenlocher & Kubicek, 1983; Lupker, 1988; McCauley, Parmalee, Sperber, & Carr, 1980; McCauley, Weil, & Sperber, 1976; Pollatsek, Rayner, & Collins, 1984; Sperber et al., 1979), or a meaningful sentence context (Barton et al., 1969; Kail & Leonard, 1986; Rudel et al., 1980, 1981; but see German, 1979, 1984, for contrary results). Picture-naming can also be primed by prior processing or production of a word that shares phonological characteristics with the target name (Lupker & Williams, 1989; McEvoy, 1988). Priming effects are generally smaller in magnitude than practice effects and are assumed to result from activation that spreads automatically from the representation of the prime to that of the target. The degree and type of relation(s) between the prime stimulus and the target are therefore important determinants of the effect. Picture-picture priming appears to originate prior to name access (Henderson et al., 1987; Huttenlocher & Kubicek, 1983; McCauley et al., 1980; Warren & Morton, 1982), whereas phonological priming presumably arises at or beyond the name access phase (Lupker & Williams, 1989).

Context may also delay picture-naming response , as demonstrated in Stroop-like picture-word interference tasks (Glaser & Glaser, 1989; La Heij, 1988; Lupker & Katz, 1981; Posnansky & Rayner, 1977). Interference may arise at various phases of the naming operation. Visual similarity between the depicted object and the object named by the distractor word may influence object identification (Neumann, 1986). A semantic relation between the target picture and the distractor word may affect name retrieval (La Heij, 1988) or a semantic decision phase that follows initial input processing but precedes name retrieval (Lupker & Katz, 1981). Inclusion of the distractor word in the set of possible responses may influence name retrieval or response generation (La Heij, 1988; La Heij & Vermeij, 1987). Recent summaries of picture-word interference issues and findings are presented by Glaser & Glaser (1989) and La Heij (1988).

Item Attributes

The cognitive models discussed earlier imply that three general classes of item attributes could be expected to influence the naming process (Paivio et al., 1989). These include (a) characteristics of the stimulus picture or object, such as its familiarity or complexity; (b) attributes of the response word (name), such as its frequency of occurrence, familiarity, or phonological composition; and (c) characteristics of the relations between stimuli and responses, such as the nature, strength, or multiplicity of referential connections. That these classes of attributes naturally covary is a complexity inherent in item attribute research. Familiar, frequently-encountered objects tend to be labelled within a language community with short readily-pronounceable names (Brown, 1958, 1976; Carroll, 1985). The names for these common objects tend to be used with a high degree of consensus across speakers. Objects that are less frequently discussed tend to have longer, more variable, and less agreed-upon names. Thus, the influence of each of the three general classes of item attributes needs to be considered relative to the effects of other correlated attributes.

Characteristics of Stimulus Objects/Pictures

Stimulus realism. A potentially important stimulus attribute, which deserves more research attention (Levie, 1987), is the degree to which picture stimuli are realistic representations of the target object. Conflicting evidence exists concerning the influence of stimulus realism on naming accuracy. In some cases, neurologically impaired adults named realistic stimuli (e.g., objects, photographs, colored drawings) more accurately than uncolored line drawings of the same objects (Benton, Smith, & Lang, 1972; Bisiach, 1966; Shuttleworth & Huber, 1988). In other studies, however, aphasics (Corlew & Nation, 1975), adults (Biederman & Ju, 1988), and young children (Nelson, 1972) named line drawings as accurately as realistic stimuli.

Reaction time measures might be more sensitive to a consistent advantage in perceptual processing time for realistic stimuli. For example, manipulations of picture exposure duration in recognition memory tasks suggest that the rate of initial perceptual processing for photographs may be faster than that for line drawings (Loftus & Bell, 1975; Ryan & Schwartz, 1956).

In naming and picture identification tasks, however, reaction time measures have also yielded inconsistent results. For example, Ostergaard and Davidoff (1985) found that colored line drawings were named faster than black and white drawings of the same objects, but color did not affect recognition of a small set of known objects when subjects were aware that color would be an unreliable cue to identification. Biederman and Ju (1988) reported no consistent RT differences for adult subjects between colored photographs and uncolored line drawings in either naming or identification tasks across several experiments. Procedural differences among experiments, particularly in the nature of the various identification tasks, may be at least partly responsible for these contradictory findings.

Size. Stimulus size also influences naming reaction times. Small pictures are named more slowly than large ones. Although this effect logically arises at the object identification phase of naming, the evidence in favor of this conclusion is mixed (McCauley et al., 1980; Theios & Amrhein, 1989).

Canonical perspective. Adults agree that there is a preferred (canonical) perspective from which to view a given object. This canonical viewpoint maximizes available information concerning the object's identity and corresponds to adults' spontaneously generated images of the object. Naming is executed most efficiently when an object is depicted from its canonical viewpoint, as compared to other possible views (Palmer, Rosch, & Chase, 1980). Several other research findings also appear to reflect the influence of canonical perspective on naming. For example, Paivio et al. (1989) demonstrated that high ratings of picture-image similarity were associated with fast naming RTs. In addition, Jolicoeur (1985, 1988; Jolicoeur & Milliken, 1989) has consistently found that object orientation affects naming RTs, with upright objects being named more quickly than objects shown in other orientations.

The Palmer et al. (1980) experiment provides strong evidence that canonical perspective affects the object identification phase of naming. Because subjects named different views of the same object, the name access and response generation phases were presumably equated. Thus, the RT advantage for canonical views logically originated at the identification phase. Jolicoeur (1988) cites other evidence consistent with an identification locus for orientation (perspective) effects.

Visual quality. Naming performance is adversely affected by manipulations that degrade the quality of the stimulus picture, for example, addition of extraneous lines (Bisiach, 1966), blurring of focus (Sperber et al., 1979), or removal of portions of line segments (Tweedy & Schulman, 1982; Wolf, 1982). On a logical basis, these quality manipulations interfere with object identification and thus, by additive factors reasoning (Sternberg, 1969), should interact with other variables assumed to affect identification. In a picture-picture priming experiment, Sperber et al. (1979) reported just such an interaction between visual quality and the semantic relatedness of prime and target pictures.

Operativity. Another stimulus characteristic that affects naming accuracy is the operativity of the target object, that is, the extent to which it can be manipulated and experienced in several sensory modalities. With frequency of the name-word controlled, aphasics and children were more accurate in naming objects high in operativity than those low in operativity (Gardner, 1973, 1974). Feyereisen, Van der Borght, and Seron (1988) replicated the effect of operativity on aphasics' naming accuracy, but found that it was eliminated when either age of acquisition of the name-word or rated picture familiarity were statistically controlled. Thus, the existence of the operativity effect is currently not well-established. Further experimental work concerning operativity, perhaps using RT measures, is probably justified in light of other evidence that multi-modal associations benefit naming (see Buckingham, 1981, for a review).

In a comprehensive factor analytic investigation of naming and imaging processes, Paivio et al. (1989) studied 31 attributes of 248 line drawings, their images, names and referential relations. Rated piccure-image similarity (the degree to which a picture resembled the image generated from its name-word) was the only picture attribute that contributed to the factor that accounted for the majority (71%) of naming RT variance. Two of the remaining factors were defined by attributes related to the familiarity and complexity of objects/pictures. These factors, however, accounted for only 2% of the explained variance in naming RTs, suggesting that, apart from their covariation with other attributes, the specific characteristics of the line drawings had little consistent effect on naming times.

Characteristics of Response Words

Word frequency. Oldfield and Wingfield (1964, 1965) reasoned that naming reaction times for pictures should be related to the familiarity of the object and its name, as estimated by the frequency with which the name word appears in print. As expected, high frequency names were given as responses more quickly than low frequency names. Frequency exerted a much larger effect on naming RT than it did on visual duration thresholds or name-picture matching speeds (Wingfield, 1968; for a similar result with children see Milianti & Cullinan, 1974). On the basis of these findings, Oldfield (1966) concluded that word frequency had its primary effect during the name access phase of naming. This view has received some support (Huttenlocher & Kubicek, 1983), but has also been questioned in light of recent evidence concerning perceptual influences on naming (Shuttleworth & Huber, 1988; Tweedy & Schulman, 1982). The word frequency effect has often been replicated with normal adults (Bartram, 1973, 1974; Carroll & White, 1973a, 1973b; Gilhooly & Gilhooly, 1979; Goodglass, Theurkauf, & Wingfield, 1984; Lachman, 1973a, 1973b; Lachman et al., 1974; Paivio et al., 1989), normal children (Milianti & Cullinan, 1974; Rochford & Williams, 1963), aphasic adults (Newcombe et al., 1965, 1971; Rochford, 1971; Rochford & Williams, 1965; Williams & Canter, 1982) and developmentally disabled children (Fried-Oken, 1984; German, 1979, 1984; Leonard et al., 1983; Rudel et al., 1981). In general, pictures with low frequency names are not only named more slowly but also less accurately than those with high frequency names. With repeated naming, low frequency items often show a greater reduction in RT than high frequency items. Relative to normal controls, linguistically disabled subjects sometimes show a greater impairment on low than on high frequency items (Newcombe et al., 1965; Rudel et al., 1981; Shuttleworth & Huber, 1988).

Age of acquisition. Carroll and White (1973a, 1973b) argued that the age at which a word is normally acquired (age of acquisition - AgeA) provides a better estimate of overall word familiarity (both spoken and written) than printed frequency. They demonstrated that subjective estimates of AgeA were better predictors of naming RTs than was printed word frequency. Words assumed to be learned earlier in life were given more quickly and accurately as naming responses than words learned at a later age. This relation of AgeA to naming RTs has been replicated with normal adults (Gilhooly & Gilhooly, 1979; Paivio et al., 1989) and children (Clark & Johnson, 1989). In addition, subjective AgeA ratings correlate well with objective indices of word acquisition age (Carroll & White, 1973a, 1973b; Clark & Johnson, 1988; Gilhooly & Gilhooly, 1980; Johnson & Clark, 1988; Lyons, Teer, & Rubenstein, 1978).

Other word characteristics that have shown a relation to naming performance include word length (Katz, 1986; Tweedy & Schulman, 1982) and rated word familiarity (Clark & Johnson, 1989; Gilhooly & Gilhooly, 1979).

Paivio et al. (1989) included various word frequency measures, rated AgeA, rated familiarity, and several measures of word structure (length, number of syllables, ease of pronunciation) in their factor analysis of attributes related to naming and imaging RTs. The word frequency measures, AgeA, and word familiarity loaded on a factor identified as verbal familiarity. AgeA also shared its variance with a verbal complexity factor that included the word structure measures. The verbal familiarity and complexity factors together accounted for 4.6% of the variation in naming RTs. More importantly, however, AgeA helped to define the common referential factor that predicted 71% of the variation in naming RTs. These results are consistent with other demonstrations that AgeA has a more substantial impact on naming RTs than word frequency or familiarity (Carroll & White, 1973a, 1973b; Gilhooly & Gilhooly, 1979).

Characteristics of Referential Relations

Generality. A given object can be categorized and named at various levels of generality (Brown, 1958). For example, the same object can be categorized or named at the subordinate (recliner), basic (chair), or superordinate (furniture) levels (Rosch et al., 1976). The generality of a particular object-name relation impacts on naming performance in a number of ways. Most names used by adults, particularly in speaking to children, refer to objects at an intermediate (basic) level of generality (Blewitt, 1983; Wales, Colman, & Pattison, 1983; White, 1982). These input characteristics are reflected in the fact that, in general, children learn basic level names prior to superordinate and subordinate names (Anglin, 1977; Nelson, 1985; Rosch et al., 1976). In timed naming tasks, basic level names usually are given faster than superordinate names by both adults (Irwin & Lupker, 1983; Jolicoeur et al., 1984; Smith & Magee, 1980; Wingfield, 1967) and children (Clark & Johnson, 1989). Objects that are typical members of their respective categories are generally named more often and more quickly at the basic than at the subordinate level, whereas the opposite is true for atypical objects (Brownell, Bihrle, & Michelow, 1986; Jolicoeur et al., 1984).

Uncertainty. An attribute that reflects the number and strength of referential relations is linguistic codability or uncertainty (Lachman, 1973a, 1973b; Lachman & Lachman, 1980; Lachman et al., 1974). Uncertainty refers to the distribution of naming responses given by a group of subjects to a particular picture. Uncertainty can be estimated by the number of different names given by a group of subjects or by calculation of *H*, a more complex measure that incorporates the number of different names and the dominance of each name (the proportion of subjects giving that name). Uncertainty estimates based on the two methods are highly correlated (Lachman & Lachman, 1980).

Normative uncertainty is a robust predictor of naming difficulty for both adults and children. Pictures with a single dominant response are named more quickly and accurately than those with multiple possible responses (Butterfield & Butterfield, 1977; Clark & Johnson, 1989; Gilhooly & Gilhooly, 1979; Johnson & Clark, 1988; Lachman, 1973a, 1973b; Lachman & Lachman, 1980; Lachman et al., 1974; Mitchell, 1989; Paivio et al., 1989). Competition among alternative names apparently increases the difficulty of the naming operation, either by diffusing spreading activation along multiple pathways or by delaying a response until competing names are inhibited (Paivio et al., 1989).

Normative uncertainty also appears to affect the naming operation independent of the effects of other correlated item attributes. For example, Lachman (1973b) compared the performance of individual subjects on low and high uncertainty pictures that were matched on individual ratings of frequency and AgeA. High uncertainty items showed consistently longer naming RTs than low uncertainty items for all subjects. Using multiple regression techniques, Lachman et al. (1974) demonstrated that uncertainty contributed uniquely to prediction of naming RTs, independent of the effects of AgeA and word frequency. Other multi-attribute studies have replicated the substantial and unique effects of uncertainty on the naming RTs of adults (Gilhooly & Gilhooly, 1979; Paivio et al., 1989) and children (Clark & Johnson, 1989). Thus, it appears that a thorough understanding of uncertainty effects is critical to an adequate account of the cognitive operations involved in naming.

Attempts to infer the mechanisms responsible for the uncertainty effect rest heavily on the assumption that the group measure of normative uncertainty estimates the uncertainty of picture-name connections within individual subjects. The validity of this assumption for adult subjects is supported by correlations of two different measures of intra-individual uncertainty with inter-individual (normative) uncertainty. First, individuals were more likely to give the same name across two naming trials for pictures that were low in normative uncertainty than for those that were high in normative uncertainty (Mitchell, 1989; Paivio et al., 1989). Giving the same name to a picture across two trials presumably reflects the existence of a stable, low uncertainty referential connection whereas a change in name across trials reflects the availability of alternative names (high uncertainty). Second, individuals were able to generate more alternative names for pictures that were high in normative uncertainty than for those low in normative uncertainty (Johnson & Clark, 1988), indicating that items high in intra-individual uncertainty were also high in inter-individual uncertainty. For children, there is, to date, no direct evidence to support the assumption that normative uncertainty estimates individual uncertainty.

It is known, however, that normative uncertainty measures based on children's naming responses differ from those based on adults' responses (Berman, Friedman, Hamberger, & Snodgrass, 1989; Butterfield & Butterfield, 1977; Johnson & Clark, 1988). These differences presumably reflect developmental changes in the number, strength, and organization of referential connections. With development, children may also improve their ability to suppress or inhibit competing name responses (Clark & Johnson, 1989; Johnson & Clark, 1988). Competition among alternative names may be especially problematic, not only for young children, but also for other less skilled namers, such as the neurologically (Mills et al., 1979) or developmentally impaired.

An important theoretical question concerns the locus of the uncertainty effect relative to the three phases of naming generally assumed by cognitive models. Because uncertainty does not influence the speed of picture-picture matching and name-picture matching, Lachman and Lachman (1980) suggested that it affects primarily the name access phase. This conclusion is questionable because the degree of perceptual processing required for matching tasks where the target is known (from the previous picture or name presentation) may be quite different than that required to identify a picture when there are no clear-cut expectations concerning its content. In addition, the normative uncertainty measures used in previous research probably confound at least two partially distinct sources of uncertainty. The first will be designated identification uncertainty. It arises at the perceptual identification phase of naming and presumably affects all subsequent phases. If a picture stimulus is ambiguous, a subject may require additional time to process the picture and achieve a correct identification and naming. Alternatively, the picture may be misidentified and therefore given an incorrect name (but often one that corresponds to an object that is perceptually and/or semantically similar to the target). If the object is unknown to the subject, it may be deliberately named by analogy to a known object or not named at all.

The second type of uncertainty can be designated referential uncertainty. Conceptually, it results from a single referent having multiple appropriate names that may be activated by correct identification of a picture, for example, boy, child, person, kid, guy. Referential uncertainty, as defined here, would presumably have its effect following the perceptual identification phase of naming.

Some empirical evidence is consistent with the suggestion that uncertainty effects arise at both object identification and post-identification phases of naming. For example, Paivio et al. (1989) found that item attributes related to normative uncertainty, such as numbers of different names and correct names, helped to define two orthogonal factors that jointly accounted for the majority of naming RT variance. The first factor included variables suggestive of identification uncertainty, such as the number of naming omissions and the number of failures to generate an image for a name-word. The second factor, which was defined by number of different names, number of correct names, and name stability, appeared to correspond more closely to a pure referential uncertainty component.

In order to develop accurate models of the naming operation, it is important to determine whether referential uncertainty contributes to naming difficulty independent of the effects of identification uncertainty and other correlated item attributes. Such a demonstration would provide strong evidence in favor of a post-identification locus for referential uncertainty.

Summary of Theoretical Issues

In summary, then, cognitive models generally assume that the naming operation is comprised of three roughly sequential phases: object identification, name access, and response generation. A fair amount is known about task conditions, subject characteristics, and item attributes that affect the accuracy and/or speed of the entire naming operation, but relatively little is known about variables that affect the various phases of the naming operation. One item attribute that may affect post-identification phases is referential uncertainty, the number and strength of alternative correct names available for a particular stimulus. The primary purpose of the current experiments was to seek converging evidence for post-identification effects of referential uncertainty on children's naming performance. To obtain this evidence, both natural language materials and a novel object-name learning paradigm were employed.

Another attribute of interest, which may affect the perceptual identification phase of naming, is the degree to which stimulus pictures are realistic representations of the target object (e.g., colored photographs are more realistic than black and white line drawings). A secondary purpose of these experiments was to assess whether stimulus realism influenced children's naming proficiency.

A further question concerned the additivity of referential uncertainty and stimulus realism effects. If, as hypothesized, these variables affect different phases of the naming process, they should have additive effects on naming RT (Sternberg, 1969; Posner, 1978; Shoben, 1982).

Developmental considerations also motivated these experiments. It is generally agreed that important developmental improvements in cognitive efficiency occur during the age period under study here (approximately four to eight years) (e.g., Case, 1985; Flavell, 1985; Piaget & Inhelder, 1971; Siegler, 1986; Sternberg & Powell, 1983). In particular, the dramatic growth in vocabulary knowledge during this period (Anglin, 1987; Templin, 1957) may influence the nature of referential uncertainty effects at various ages. In addition, there is evidence from category naming tasks that young children may be particularly vulnerable to interference from competing names (Clark & Johnson, 1989; Johnson & Clark, 1988). Thus, the current experiments assessed whether younger children showed different effects of referential uncertainty than older children. The effects of stimulus realism might also vary with development. On the assumption that mental representations for objects are relatively concrete (Paivio, 1971, 1986), young children may initially show a processing advantage for realistic, as compared to abstract, stimuli. Because of repeated practice in naming abstract pictures, this advantage for realistic stimuli may no longer be evident in adulthood (Biederman & Ju, 1988).

Thus, the present experiments compared the effects of referential uncertainty and stimulus realism on the naming performance of normally developing children from four to eight years of age. Taken together, the results should: (a) provide evidence concerning the 'stence and locus of referential uncertainty and stimulus realism effects on children's naming, (b) improve knowledge of developmental changes in naming, and (c) help to inform and constrain cognitive models of the naming operation.

NORMING STUDIES

The purpose of the norming studies was to identify pictures (line drawings) of common objects that young children could recognize reliably and name correctly. Pictures with a single dominant name would serve as possible low referential uncertainty stimuli for Experiment 1; pictures with two or more acceptable names would serve as possible high uncertainty stimuli. The two sets of stimulus pictures would be equated on age of word acquisition (AgeA) and number of syllables in the name-words.

The preliminary stimulus selection procedure involved three separate steps. First, children in the target age range (junior kindergarten [JK] and grade one [G1]) named line drawings of common objects. Second, adults judged whether the children's responses were acceptable names for the pictured items. Third, adults rated AgeA for the name responses to each picture. Procedures and results for each of the three steps are described in turn.

Children's Naming Responses

Three separate samples of children named potential stimulus pictures. Naming distributions for each picture were based on the responses of 16 JK and 16 grade 1 children as described below.

Method - Sample 1

Subjects. Sample 1 included 32 JK (*M* age = 4;11) and 32 G1 (*M* age = 7;2) children who named line drawings as part of another investigation (Clark & Johnson, 1989).

Stimuli. The naming stimuli were 96 slides of black and white line drawings of familiar objects. Drawings were selected from available sources (e.g., Snodgrass & Vanderwart, 1980; Paivio et al., 1989). Each subject named half (48) of the stimuli under instance naming (basic level) instructions and the other half under category naming (superordinate) instructions. Only data from the instance naming conditions (1 Ss per grade per item) are relevant here.

Procedure. Slides were projected on a small rear projection screen located on the table in front of the subject. Children were instructed to say the picture's "own" (instance) name as quickly as possible upon presentation of the slide. Naming responses and reaction times were recorded.

Results - Sample 1

The distribution of the various naming responses was determined for each item. Items that elicited no more than two (of 32) naming omissions were retained for further consideration. This initial inclusion criterion was met by 46/96 items named by Sample 1 subjects. These items, their naming distributions, and other characteristics are shown in Table A-1 of Appendix A.

Method - Samples 2 and 3

Subjects. Sample 2 included 16 JK (*M* age = 4;6) and 16 G1 (*M* age = 6;8) children, as did Sample 3 (JK *M* age = 4;8; G1 *M* age = 6;7). Samples 2 and 3 named line drawings after they completed a name-picture matching task for another investigation (Clark & Johnson, 1989).

Stimuli. The picture stimuli were 56 line drawings (28 for Sample 2; 28 for Sample 3) similar to those described for Sample 1. Each line drawing was pasted on a 3" X 5" index card.

Procedure. Children named each picture as it was placed on the table in front of them. Name responses were recorded.

Results - Samples 2 and 3

Naming distributions were again determined for each item. The initial inclusion criterion of two or fewer naming omissions was met by 24/28 items named by Sample 2, and by 25/28 items named by Sample 3. Thus, a total of 95 items, which are listed in Appendix A, remained for further consideration.

Name Acceptability Judgments

The next step in the stimulus selection procedure was to determine which of the naming responses to each item were acceptable, alternative names for the pictured object. The goal was to exclude pictures that children frequently misidentified. Of the 95 items that remained under consideration, 23 had been named only with their nominally correct response, which was assumed to be acceptable. The 72 remaining items elicited a total of 253 naming responses (M = 3.51 names per item, excluding omissions). Adults judged the acceptability of each response as a name for the pictured object.

Method

Subjects. The judges were ten psychology graduate students (5 female, 5 male) who were naive to the purpose of subsequent experiments.

Materials. The 72 items that elicited more than one name response were presented to the judges in booklets consisting of nine pages. Each page was divided into eight sections. Each section contained one picture accompanied by its naming responses in random order. A blank space for recording an acceptability judgment preceded each name response. Items were randomly ordered on each page, but this order was the same for all raters. The order of pages was randomized independently for each judge, with the restriction that each page appeared at least once as the first page across the ten judgment booklets.

Procedure. Written instructions accompanied each booklet. Subjects were asked to judge ("Y" for "yes"; "N" for "no") whether each response was an acceptable name for the pictured object. The exact instructions for the judgment task and a sample page from a judgment booklet are presented in Appendix B.

Results

The acceptability judgments were highly reliable (Cronbach's alpha = .97). Appendix A (Table A-1) shows the judgment results for each name response. Names that were given "yes" judgments by six or more of the ten judges were classified as acceptable alternative names for the target object; other naming responses and omissions were classified as unacceptable. Pictures with at least 30/32 acceptable naming responses were retained for further consideration. A total of 70 items met this criterion (47/72 judged items plus the 23 items that elicited only their nominally correct name).

Age of Word Acquisition Ratings

The third step in the stimulus selection procedure was to obtain ratings of age of word acquisition for the dominant names and frequent alternative responses to the 70 remaining pictures. Low and high referential uncertainty stimuli could then be equated on AgeA.

Method

Subjects. Sixteen adult females who were familiar with the speaking vocabularies of young children served as raters. The majority of raters (14/16) were professionals who worked regularly with children (7 preschool teachers, 6 speech/language pathologists, 1 audiologist).

The two additional raters were parents of young children, as were many of the professionals.

<u>Materials</u>: A total of 90 words were presented for rating in booklets containing four pages of 22 or 23 words per page. A blank for recording the AgeA rating preceded each word. The order of words on each page was randomly determined but the same for all raters. The order of pages within booklets was counterbalanced so that each page appeared equally often in each of the four possible page positions across the 16 rating booklets.

<u>Procedure</u>. Written instructions (see Appendix C) accompanied each rating booklet. Raters judged age of correct word usage by rating each item on a 5-point scale relative to other words on the list. A rating of 1 designated a word that was acquired relatively early; a rating of 5 designated a word acquired relatively late.

<u>Results</u>

The AgeA ratings were highly reliable (Cronbach's alpha = .96) and significantly correlated with similar ratings obtained by Carroll and White (1973a), $r = .74$, $p < .001$, 37 items; Paivio et al. (1989), $r = .82$, $p < .001$, 46 items; and Clark and Johnson (1989), $r = .90$, $p < .001$, 48 items. AgeA averages for the rated words are shown in Table A-1 of Appendix A. Values ranged from a low of 1.25 (car) to a high of 4.88 (jewelry), ($M = 3.04$, $SD = .9$). The AgeA ratings were then used, in conjunction with other criteria, to select the stimuli for Experiment 1.

EXPERIMENT 1

Experiment 1 assessed the effects of referential uncertainty (low vs. high) and stimulus realism (colored photographs vs. line drawings of the same objects) on children's reaction times in two tasks, naming and object decision (Kroll & Potter, 1984). The object decision task involves pictures of real objects and pictures of nonobjects that are composed of parts of real objects. The subject must decide as quickly as possible whether the stimulus is or is not a real object. Like naming, object decision presumably requires object identification under conditions where the subject has no specific expectations regarding the nature of the stimulus. The object-like nature of the nonobject distractors probably precludes a strategy of responding merely on the basis of gross physical features of the stimuli (Lupker, 1988). Unlike naming, however, object decision presumably does not require name access (Huttenlocher & Kubicek, 1983; Kroll & Potter, 1984) because objects can be identified on the basis of their nonverbal characteristics. Under these assumptions and the assumption that the phases of the naming operation are roughly sequential, a variable that affects object identification should influence both tasks similarly, whereas a variable that affects name access or generation should affect naming but not object decision. Experiment 1 was designed to determine whether (a) referential uncertainty increases naming, but not object decision, latencies; (b) realistic stimuli (colored photographs) result in faster naming and object decision times than abstract stimuli (line drawings of the same objects); (c) the effects of stimulus realism and referential uncertainty vary as a function of development and comprehension vocabulary ability; and (d) stimulus realism and referential uncertainty have additive effects on naming latencies.

Method

Subjects

The subjects were 120 children, 40 from junior kindergarten [JK] (ages 4;5 to 5;5, M = 4;11), 40 from senior kindergarten [SK] (ages 5;5 to 6;5, M = 5;10), and 40 from grade one [G1] (ages 6;5 to 7;8, M = 7;0). Written parental consent was obtained prior to each subject's participation (see Appendix D for copies of the letter of information and parental consent form). The majority of JK subjects (33/40) and all SK and G1 participants were recruited from two London, Ontario, public schools. Seven additional JK children were obtained from a university preschool (2 Ss) and a Montessori preschool program (5 Ss). Data were replaced for one G1 child who often did not respond until specifically requested to do so. All children spoke English as their primary language. Equal numbers of boys and girls participated at each grade level. The design included referential uncertainty (low, high) and stimulus realism (photographs [P], line drawings [L]) as within-subjects factors and grade (JK, SK, G1), task (naming, object decision), and stimulus order (P-L, L-P) as between-subjects factors. One quarter of the children at each grade level (10 total; 5 boys; 5 girls) were randomly assigned to one of the four possible combinations of task and stimulus order: (a) naming P-L, (b) naming L-P, (c) object decision P-L, and (d) object decision L-P.

Object Stimuli

Slides (colored photographs and black-on-white line drawings) of 40 familiar objects (20 low uncertainty, 20 high uncertainty) served as the target stimuli for the naming and object decision tasks. To test fairly whether stimulus realism affects the ease of object identification during naming, it was essential to minimize misidentifications of the target objects and equate, as much as possible, the name access and response phases of the naming operation for both photographs and line drawings. Thus, the target objects were selected from the pool of items identified in the norming studies described earlier. To review briefly, this pool contained items that were correctly identified in line drawing form by at least 30/32 children (16 JK; 16 G1). Correct identification was defined by children's provision of an acceptable name for the object, as determined by adult judges. AgeA ratings were obtained for the dominant name for each item.

Two groups of items, which differed in referential uncertainty, were selected according to the following criteria. Low referential uncertainty items were those for which (a) the dominant name was given by at least 30/32 children and (b) no more than two different names (acceptable or unacceptable) were elicited from the group. High referential uncertainty items were those for which (a) the dominant name was given by fewer than 30/32 children and (b) at least two acceptable alternative names (e.g., "lips," "mouth," "smile" for a picture of lips) were elicited from the group. Twenty items clearly met the criteria for the high referential uncertainty group. A low referential uncertainty group of 20 items was then matched to the high uncertainty group on (a) mean AgeA for the dominant response and (b) mean number of syllables in the dominant response. Tables 1 and 2, respectively, show the low and high referential uncertainty items and their characteristics. As planned, the groups differed significantly on two measures of

Table 1

Low Referential Uncertainty Stimulus Items for Experiment 1

Item Name	DifNm	H	AgeA	Unacc	Sylls
apple	1	.00	1.50	0	2
sock	2	.20	2.06	1	1
pig	2	.20	2.06	1	1
chair	1	.00	2.25	0	1
cake	2	.20	2.44	1	1
key	1	.00	2.88	0	1
kite	1	.20	2.94	1	1
fork	1	.20	3.00	1	1
leaf	2	.20	3.38	1	1
present	2	.20	3.50	0	2
ladder	2	.20	3.56	1	2
turtle	2	.40	3.56	2	2
elephant	1	.00	3.75	0	3
scissors	1	.00	3.81	0	2
watch	2	.20	3.81	1	1
candle	1	.34	4.06	2	2
shorts	2	.34	4.13	0	1
piano	1	.00	4.13	0	3
umbrella	1	.00	4.25	0	3
square	1	.00	4.44	0	1
MEANS	1.45	.14	3.28	.60	1.60
SDs	.51	.13	.85	.68	.75

Table 2

High Referential Uncertainty Stimulus Items for Experiment 1

Item Name	DifNm	H	AgeA	Unacc	Sylls
cat (kitten)	4	1.52	1.50	0	1
boat (ship)	2	.45	2.06	0	1
boat (sailboat)	2	.99	2.06	0	1
doll	4	.86	2.06	2	1
leg	2	.97	2.31	0	1
teddybear	2	1.00	2.56	0	3
bowl	3	.64	2.69	1	1
pants	4	.60	2.75	0	1
wheel (tire)	2	.97	3.25	0	1
purse	5	1.22	3.50	2	1
lips	4	1.26	3.50	2	1
telephone	2	.76	3.69	0	3
rabbit	3	1.68	3.69	1	2
stove	3	1.04	3.81	1	1
lamp	3	.74	3.94	1	1
bicycle (tricycle)	5	1.87	4.25	1	3
motorcycle	4	1.18	4.44	1	4
necklace	4	.73	4.44	2	2
stool	6	1.67	4.63	2	1
dollar	4	1.44	4.69	1	2
MEANS	3.40	1.08	3.29	.85	1.60
SDs	1.19	.40	.98	.81	.94

uncertainty, the number of different names given across subjects (low *M* = 1.45, *SD* = .51; high *M* = 3.40, *SD* = 1.19), $t(38) = 6.75$, $p < .001$, and *H* (Snodgrass & Vanderwart, 1980), a measure that considers number of different names as well as the proportion of subjects giving each name, (low *M* = .14, *SD* = .13, high *M* = 1.08, *SD* = .40), $t(38) = 10.03$, $p < .001$. The groups did not differ significantly on rated AgeA (low *M* = 3.28, *SD* = .85; high *M* = 3.29, *SD* = .98), number of syllables (low *M* = 1.60, *SD* = .75; high *M* = 1.60, *SD* = .94), or number of unacceptable responses (low *M* = .60, *SD* = .68; high *M* = .85, *SD* = .81), all *t*s < 1.06, *p*s > .29.

Colored pictures or objects representing the 40 target items were photographed as slides on a white background.[1] Line drawings of the same items were then drawn by a professional artist using prints of the slides as models. These line drawings were then photographed as black-on-white slides. Thus, the two types of stimulus slides showed the same objects in the same sizes and orientations. Similar slides of eight additional objects from the item pool served as practice stimuli. Figures 1 and 2 show the line drawings of the low uncertainty and high uncertainty items, respectively.

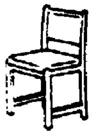
[1] As much as possible, the experimental stimulus for a particular object was chosen to be similar in overall appearance to the picture of the same object that was used in the norming studies. Name acceptability judgments obtained for the norming pictures were, thus, assumed to be applicable to the experimental pictures. The validity of this assumption was supported by the observation that the distributions of naming responses to the experimental pictures were similar to those for the norming stimuli. In addition, naming distributions were similar for both versions (colored photograph and line drawing) of the experimental items (see section below entitled Validity of uncertainty groupings).

Figure 1. Line drawings of low referential uncertainty stimulus items for Experiment 1.


apple


sock


pig

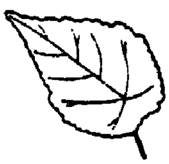

chair


cake

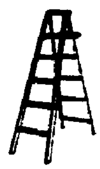

key


kite


fork

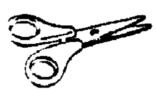

leaf


present


ladder


turtle


elephant


scissors


watch


candle


shorts


piano


umbrella

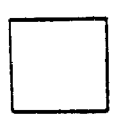
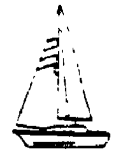

square

Figure 2. Line drawings of high referential uncertainty stimulus items for Expe.iment 1.

cat (kitten)

boat (ship)



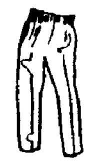
boat (sail)

doll

leg

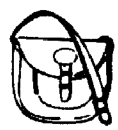
teddybear

bowl



pants

wheel (tire)



purse

lips

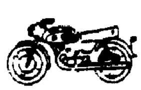
telephone

rabbit

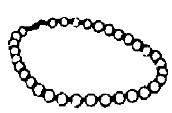
stove

lamp

bicycle (tri)



motorcycle



necklace

stool

dollar

<u>Nonobject Stimuli</u>

The distractor stimuli were slides of colored photographs and black-on-white line drawings of 20 nonobjects, modelled after those used by Kroll and Potter (1984). Four additional nonobjects served as practice stimuli. Each nonobject was constructed from parts of real objects and had an object-like appearance. As in the case of the target objects, the nonobjects were photographed as colored slides which were made into prints. The artist used each print to produce a black-on-white line drawing that corresponded in size and orientation to the photograph of the nonobject. The line drawings were then photographed as slides. Figure 3 shows the line drawings of the nonobjects used in Experiment 1. In order to make the naming and object decision tasks as similar as possible, the nonobjects were also presented during the naming task (see below).

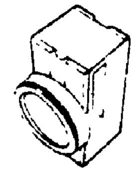
<u>Stimulus Lists</u>

Target and distractor items were assigned to five blocks of 12 items each (4 low uncertainty; 4 high uncertainty; 4 nonobjects). The nonobjects were assigned randomly to each block. The low and high uncertainty groups were each divided into quarters according to rated AgeA. One item from each quarter of each uncertainty group was assigned randomly to each block. The resulting blocks ranged in mean rated AgeA from 3.16 to 3.36. The largest difference among blocks in rated AgeA was not significant, $t(14) < 1$. In addition, a practice block consisting of 8 objects and 4 nonobjects was formed. Table 3 shows the items assigned to each block.

Five different list orders were constructed so that each block of items appeared once in each possible list position. Each child received

Figure 3. Line drawings of nonobject distractor stimulus items for Experiment 1.


1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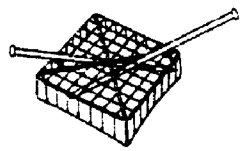
3


4


5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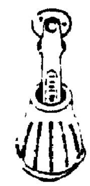
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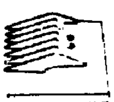
8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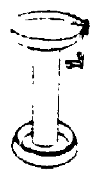
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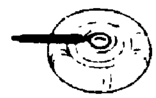
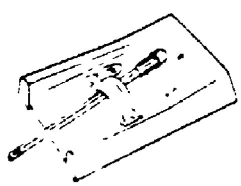

11


12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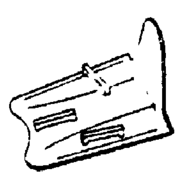
14


15


16


17


18


19


20

Table 3

Assignment of Target and Nonobject Items to Blocks in Experiment 1

Item	Type[a]	Item	Type	Item	Type
Practice Block		Block 1		Block 2	
shovel	PO	cake	L	apple	L
carrot	PO	present	L	leaf	L
bed	PO	turtle	L	scissors	L
tv	PO	shorts	L	umbrella	L
mouse	PO	boat(sail)	H	doll	H
ball	PO	wheel	H	bowl	H
car	PO	rabbit	H	telephone	H
butterfly	PO	bicycle	H	motorcycle	H
n-o p1	PN	n-o 1	N	n-o 5	N
n-o p2	PN	n-o 2	N	n-o 6	N
n-o p3	PN	n-o 3	N	n-o 7	N
n-o p4	PN	n-o 4	N	n-o 8	N
Block 3		Block 4		Block 5	
sock	L	pig	L	chair	L
kite	L	fork	L	key	L
watch	L	ladder	L	elephant	L
piano	L	candle	L	square	L
cat	H	boat(ship)	H	leg	H
pants	H	purse	H	teddybear	H
lips	H	lamp	H	stove	H
stool	H	dollar	H	necklace	H
n-o 9	N	n-o 13	N	n-o 17	N
n-o 10	N	n-o 14	N	n-o 18	N
n-o 11	N	n-o 15	N	n-o 19	N
n-o 12	N	n-o 16	N	n-o 20	N

[a] PO = practice object; PN = practice nonobject; L = low uncertainty stimulus; H = high uncertainty stimulus; N = nonobject stimulus.

the same list order for both P and L trials, but the random ordering of items within each block was different for each stimulus type (P or L). No more than three object or nonobject trials occurred consecutively within a block. Two children (1 boy, 1 girl) in each grade-task-stimulus order cell were assigned randomly to each of the five list orders.

Procedure

Each child was tested individually for approximately 20 to 30 minutes. For both the naming and object decision tasks, slides were projected on a small rear projection screen located on a table in front of the subject. The experimenter wrote down each response. A tape recorder recorded the opening of the projector shutter and the child's response for each slide. Response latencies were determined later from the tape recording (see Response Timing below).

For the naming task, each child was instructed to name the object stimuli and to respond "no" to the nonobject stimuli as quickly as possible. The exact instructions for the naming task are presented in Appendix E. Twelve practice items (eight objects, four nonobjects) preceded the 60 test trials (40 objects, 20 nonobjects) for the first stimulus type (either P or L). The practice and test trials for the second stimulus type were then presented in a similar fashion. The experimenter recorded all spontaneous responses given by the child.

For the object decision task, each child was instructed to judge, as quickly as possible, whether the stimulus was a real object ("yes" response) or not ("no" response). The exact instructions for the object decision task appear in Appendix E. As in the naming task, twelve practice items preceded the 60 test trials (40 "yes", 20 "no") of the first stimulus type. The second stimulus type was presented in a similar fashion. The experimenter recorded the child's responses and any spontaneous naming of the target pictures.

Finally, each child completed a comprehension vocabulary test, the Peabody Picture Vocabulary Test - Revised, Form L (Dunn & Dunn, 1981). The test was administered and scored according to the procedures recommended in the test manual.

Scoring of Responses

Object decision and naming task analyses were based on children's first responses to each item, unless otherwise noted. "No" responses to nonobjects were considered correct for both tasks. In object decision, "yes" responses to objects were also correct.

Correct naming responses to objects included names that had been judged during the norming procedures as acceptable alternative names for each item. In addition, acceptability judgments were obtained for name responses that had not been generated in the norming studies. The procedure for name acceptability judgments was the same as that used earlier. Ten graduate students again served as judges (nine were also judges for the norming study). All names judged as acceptable by six or more of the ten judges were considered to be correct naming responses. Singular and plural forms of the same word were considered equivalent. Table 4 shows the acceptable naming responses for the low and high uncertainty items.

Uncertainty Measures

The distribution of naming responses (acceptable and unacceptable) to each object item was used to calculate two measures of inter-individual uncertainty, the number of different names given by the group

Table 4

Number (120 possible) of Acceptable (Uppercase) and Unacceptable (Lowercase) Naming Responses to Low and High Uncertainty Items in Experiment 1

Dominant Name	Alternative Names
	Low Uncertainty Items
APPLE 100	orange 11, tomato 3, pumpkin, ball
CAKE 101	PIECE OF CAKE, muffin 6, pie 2, cheese 2, cookie 2, donut
CANDLE 102	CANDLESTICK 2, CANDLELIGHT 2, LIGHT, fire, baby bottle, birthday cake
CHAIR 117	book
ELEPHANT 118	lion, giraffe
FORK 117	spoon 3
KEY 118	
KITE 115	flag
LADDER 115	fence
LEAF 109	tree 3, feather 2, maple leaf 2
PIANO 114	drum
PIG 114	cow 6
PRESENT 105	BOX 5, BIRTHDAY PRESENT 3, PRESENT BOX, GIFT, cake
SCISSORS 120	
SHORTS 87	PANTS 31, jeans
SOCK 117	stick
SQUARE 96	BOX 10, PAPER 4, PIECE OF PAPER 2, BLOCK, PINK, PINK SQUARE, circle 2, tv
TURTLE 117	SNAPPING TURTLE
UMBRELLA 119	
WATCH 115	clock 3, tick tock

table continues

Dominant Name	Alternative Names
	High Uncertainty Items
BIKE 42	TRICYCLE 41, BICYCLE 33, TRIKE 3
BOAT (SAIL) 94	SAILBOAT 19, SHIP 3, SAIL
BOAT (SHIP) 97	SHIP 13, YACHT, sailboat 3, boat sail
BOWL 108	DISH 3, cup 5, plate 3, juice
CAT 84	KITTEN 18, KITTY 10, KITTY CAT 7, PUSSY CAT
DOLL 83	RAGGEDY ANN 17, DOLLY 9, RAGGEDY ANN DOLL 5, BABY DOLL, GIRL, TOY, person
DOLLAR 64	MONEY 26, ONE DOLLAR 14, DOLLAR BILL 7, ONE DOLLAR BILL 4, penny, button
LAMP 99	LIGHT 15, MUDDY LAMP, plan 2, lantern, plant
LEG 100	FOOT 16, KNEE 3, sock
LIPS 106	MOUTH 5, SMILE 3, lipstick 2, bowl
MOTORCYCLE 98	MOTORBIKE 6, BIKE 6, bicycle 5, motor
NECKLACE 106	BEADS 6, BRACELET 3, PEARLS
PANTS 104	JEANS 11, BLUE JEANS 3
PURSE 112	BAG 2, KNAPSACK, belt 2, horse saddle
RABBIT 64	BUNNY 41, BUNNY RABBIT 10, snowball
STOOL 66	CHAIR 46, SEAT, bench 2
STOVE 88	OVEN 26, microwave 3
TEDDYBEAR 80	BEAR 32, TEDDY 8
TELEPHONE 115	PHONE 5
TIRE 79	WHEEL 38, picture

Note. Responses not followed by a number were given only once.

of subjects (DifNm) and H, a measure that also considers the proportion of subjects giving each response (Snodgrass & Vanderwart, 1980). Each measure was calculated separately for responses to photographs (P) and to line drawings (L). Name stability scores were calculated to estimate intra-individual uncertainty (high name stability presumably reflects low uncertainty). By items, name stability scores represent the proportion of subjects who gave the same name for an item on both naming trials (P and L). By subjects, name stability scores represent the proportion of items for which a subject used the same name on both trials. Name changes were assessed by a conservative criterion, which designated non-naming errors (omissions, "yes" or "no" responses) on one or both trials as stable responses.

Response Timing

The experimenter timed the children's responses from the audiotape recordings made during the experiment. At the sound of the opening of the slide projector shutter, the experimenter pressed a computer key to start a timer. A second keypress stopped the timer at the initiation of the subject's response.

A graduate student who was naive to the experimental hypotheses provided data for a reliability check of the experimenter's timing results. After initial instruction and practice in the timing procedure, the graduate student timed a random selection of 20% of the audiotapes from each grade-task condition (4 Ss per condition; 24 total). Tapes were selected for reliability analysis after the experimenter had completed timing for all subjects.

Results

The results are reported in the following sequence. First, evidence is presented to confirm (a) the reliability of the response timing procedures and (b) the validity of the referential uncertainty groupings. Second, the main hypotheses of the study are evaluated, using RTs and errors for the object stimuli in the naming and object decision tasks. Third, several analyses focus on the nonobject rejection data from both tasks. Throughout the report, reaction time results are given in seconds; error results are proportions.

Preliminary Issues

Timing reliability. The reliability of the response timing procedure was demonstrated by the high correlation ($r = .98$, $p < .001$) between the experimenter's response times ($N = 2880$, $M = 1.647$, $SD = .906$) and those of the reliability timer ($M = 1.635$, $SD = .932$). In addition, analysis of variance (Rater X Grade X Task X Uncertainty X Stimulus Realism with repeated measures on the last four factors) suggested that the timing responses were not systematically biased with regard to the experimental hypotheses. The main effect of rater and all interactions of rater with other factors were not significant, Fs < .20. Therefore, the latencies timed by the experimenter were used for subsequent analyses.

Validity of uncertainty groupings. The distributions of naming responses yielded several uncertainty measures (see Method) that demonstrated the validity of the original assignment of items to low and high uncertainty groups. Table 5 shows the means, standard deviations, and correlations among the various item uncertainty measures for the low and high uncertainty groups, separately and together. As intended, the

Table 5

Descriptive Statistics and Correlations among Uncertainty Measures for Low and High Uncertainty Item Groups in Experiment 1

Uncertainty Measure	2	3	4	5	*M*	*SD*
Low Uncertainty (*n* = 20 items)						
1 DifNm (P)	.77	.89	.64	-.34*	2.55	1.88
2 DifNm (L)	---	.70	.88	-.34*	2.60	1.73
3 H (P)		---	.65	-.48	.40	.39
4 H (L)			---	-.67	.45	.43
5 Name Stability (items)				---	.95	.07
High Uncertainty (*n* = 20 items)						
1 DifNm (P)	.63	.61	.54	-.49	3.80	1.01
2 DifNm (L)	---	.25*	.45	-.20*	3.95	1.23
3 H (P)		---	.87	-.71	1.05	.43
4 H (L)			---	-.64	1.04	.46
5 Name Stability (items)				---	.86	.07
All (*N* = 40 items)						
1 DifNm (P)	.77	.77	.65	-.51	3.18	1.62
2 DifNm (L)	---	.61	.74	-.45	3.28	1.63
3 H (P)		---	.85	-.74	.73	.52
4 H (L)			---	-.76	.75	.53
5 Name Stability (items)				---	.91	.08

* not significant, $p < .05$.

two groups differed significantly and in the expected direction on all measures of uncertainty: (a) DifNm (P), $\underline{t}(38) = 2.63$, $\underline{p} < .05$; (b) DifNm (L), $\underline{t}(38) = 2.84$, $\underline{p} < .01$; (c) $\underline{H}$ (P), $\underline{t}(38) = 5.04$, $\underline{p} < .001$; (d) $\underline{H}$ (L), $\underline{t}(38) = 4.23$, $\underline{p} < .001$, (e) name stability by items, $\underline{t}(38) = 4.29$, $\underline{p} < .001$, and (f) name stability by subjects, $\underline{t}(59) = 8.31$, $\underline{p} < .001$.

A critical assumption underlying this experiment is that uncertainty measures calculated across a group of subjects (inter-individual) estimate the uncertainty of referential connections for individual subjects (intra-individual). The bottom panel of Table 5 provides direct evidence in support of this assumption in the form of substantial (negative) correlations of various inter-individual uncertainty measures (DifNm and $\underline{H}$) with an intra-individual uncertainty measure (name stability across trials).

A final series of comparisons demonstrated that uncertainty differences were not confounded with stimulus realism. No significant differences between photographs and line drawings were found for DifNm or $\underline{H}$ values, both $\underline{t}$s < 1.

Despite the lack of group differences, one item in the low uncertainty condition (apple) appeared problematic. Apparently, visual characteristics made the line drawing version of this item difficult to identify reliably. As a result, large discrepancies between the photograph and line drawing version of the item were apparent in both naming accuracy (P = .967; L = .700) and uncertainty (P = .244; L = 1.340 for $\underline{H}$ values). The adults who performed name acceptability judgments also experienced difficulty with this drawing, as evidenced by their frequent questions concerning its identity. Consequently, later analyses were conducted both with and without the data for this item.

Analyses of Object Data

The overall proportion of errors in the experiment was .080 (1147 errors in 14,400 responses). The error proportion for objects (.052 = 501/9600) was lower than that for nonobjects (.135 = 646/4800). The relatively low error rate for responses to objects suggested that: (a) the norming procedures successfully identified picture stimuli that were familiar to young children, and (b) the estimation of missing reaction times for error responses could be based on a fairly high proportion of correct responses within each experimental cell.

Estimation of missing RTs. Correct RTs (N = 13,253, M = 1.594, SD = .827) were truncated at +3 SDs to reduce the influence of extreme values on means. Truncation affected a total of 222 object and nonobject times (.015). For the object data only, 108 values were truncated (.011). Error times in the object data were replaced by estimates derived using a method recommended by Myers (1979, p. 177-178). The estimation method was applied within each of the 48 cells defined by the factors of interest (grade, task, stimulus order, uncertainty, stimulus realism). Each cell included 200 possible observations (20 items X 10 subjects). To begin the estimation procedure, all but one of the missing times were replaced by the mean correct RT for the cell. The remaining time was then estimated from three totals, the total of other observations in the cell (N = 199), the total of other observations for the subject (n = 19), and the total of other observations for the item (n = 9). The estimated value was then inserted into the cell and used in estimation of the remaining missing values. For each cell, two iterations through the procedure were sufficient to achieve stable estimates. Changes in cell means from the first to the second iteration averaged less than two milliseconds.

Statistical procedures. The primary experimental questions involved comparisons of reaction times for naming and object decision responses to the object stimuli, but error rates were also examined. Latency and error data were analyzed in separate 3 (grade) X 2 (task) X 2 (stimulus order) X 2 (uncertainty) X 2 (stimulus realism) analyses of variance with repeated measures on the last two factors. Subjects (nested in grade, task, stimulus order) and items (nested in uncertainty) were treated as random factors (Clark, 1973), thereby insuring that significant effects were reliable across both subjects and items. Quasi F ratios (F'') were calculated by adding appropriate mean squares to both the numerator and denominator. This method ensures that negative values for denominator mean squares will not be obtained (Kirk, 1982, p. 394-395). The analyses have power of approximately .80 ($p <$ .05) to detect main effects and interactions that account for approximately 6% of the variance remaining after all other effects are taken into account (Cohen, 1977). Interactions involving the subjects and items factors were tested at a more conservative level ($p < .001$), because of the large numbers of degrees of freedom and resulting power associated with tests of these effects. These interactions were evaluated because of their potential to further our understanding of the nature of subject and item differences in naming performance.

In view of the problem noted earlier with one of the low uncertainty items (apple), the object analyses were conducted with both 20 items and 19 items per uncertainty group. For the 19 item analyses, the high uncertainty item corresponding to apple in AgeA was omitted (*cat*). Because results from the two analyses were similar, only the 19 item results will be reported.

Significant main effects of grade (the only fixed factor with more than two levels) were followed up by pairwise comparisons of means using Tukey's HSD procedure. Post hoc comparisons of means for interactions involving repeated measures were evaluated with correlated t-tests involving subject means collapsed over items as recommended by Myers (1979, pg. 210). An advantage of this procedure is that each contrast is assessed against an error term specific to that contrast. For all post hoc analyses, the error rate for a particular collection of tests was controlled at .05 by the Bonferroni procedure.

Predictions. To review briefly, the primary predictions of interest were: (a) uncertainty will affect naming but not object decision latencies, i.e., there will be an interaction of task and uncertainty; (b) both naming and object decision will be faster for photographs than for line drawings; and (c) stimulus realism and referential uncertainty will have additive effects on naming RTs. Interactions involving grade, if present, might suggest the nature of developmental changes in cognitive processing for these tasks.

Descriptive statistics. Table 6 shows the means and standard deviations for the main experimental factors and the significant two-way interactions in the 19-item and 20-item RT data. Means and standard deviations for the corresponding error data are also shown.

Effects of referential uncertainty. In the RT analysis, the predicted interaction of task and uncertainty was reliable, $F''(1,57) = 4.26$, $p < .05$, and is shown in Figure 4. As expected, uncertainty affected naming but not object decision reaction times. Naming RTs were

Table 6

Means and Standard Deviations for Main Experimental Factors and Selected Interactions in Reaction Time and Error Analyses for Object Stimuli in Experiment 1

Effect	RTs (19)[a]	Errors (19)[a]	RTs (20)[b]	Errors (20)[b]
Grade				
JK	1.561 (.572)	.080 (.271)	1.564 (.577)	.080 (.272)
SK	1.483 (.540)	.042 (.202)	1.482 (.541)	.045 (.207)
G1	1.399 (.473)	.032 (.175)	1.399 (.474)	.032 (.175)
Task				
Nmg	1.540 (.574)	.040 (.196)	1.539 (.578)	.042 (.201)
OD	1.422 (.483)	.063 (.242)	1.423 (.485)	.062 (.242)
Stimulus Order				
P-L	1.485 (.552)	.049 (.216)	1.484 (.552)	.049 (.217)
L-P	1.477 (.515)	.054 (.225)	1.479 (.520)	.055 (.228)
Uncertainty				
Low	1.465 (.524)	.054 (.227)	1.471 (.528)	.057 (.232)
High	1.496 (.543)	.048 (.214)	1.492 (.545)	.047 (.212)
Stimulus Realism				
Photo	1.467 (.521)	.052 (.222)	1.462 (.520)	.051 (.220)
Line	1.495 (.546)	.051 (.219)	1.500 (.552)	.054 (.225)
Task X Uncertainty				
Nmg Low	1.500 (.554)	.043 (.202)	1.506 (.559)	.049 (.215)

table continues

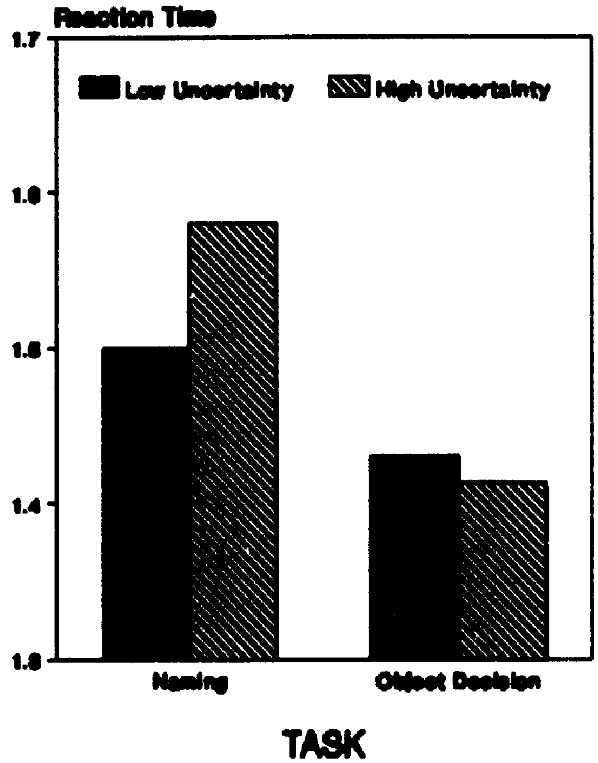
Effect	RTs (19)	Errors (19)	RTs (20)	Errors (20)
Task X Uncertainty (cont.)				
Nmg High	1.580 (.591)	.037 (.189)	1.573 (.594)	.035(.185)
OD Low	1.430 (.490)	.066 (.249)	1.436 (.493)	.066 (.248)
OD High	1.413 (.476)	.059 (.236)	1.411 (.476)	.059 (.235)
Grade X Stimulus Realism				
JK Photo	1.589 (.599)	.090 (.286)	1.587 (.600)	.087 (.282)
JK Line	1.533 (.542)	.070 (.255)	1.540 (.552)	.074 (.261)
SK Photo	1.444 (.489)	.036 (.187)	1.440 (.490)	.038 (.190)
SK Line	1.521 (.584)	.049 (.215)	1.524 (.585)	.052 (.222)
G1 Photo	1.367 (.437)	.030 (.170)	1.360 (.431)	.028 (.165)
G1 Line	1.431 (.504)	.034 (.180)	1.437 (.510)	.035 (.184)
Stimulus Order X Stimulus Realism				
P-L Photo	1.498 (.558)	.051 (.220)	1.492 (.555)	.049 (.216)
P-L Line	1.471 (.547)	.047 (.212)	1.476 (.549)	.050 (.217)
L-P Photo	1.436 (.480)	.053 (.224)	1.433 (.482)	.052 (.223)
L-P Line	1.519 (.544)	.054 (.226)	1.525 (.553)	.057 (.233)
TOTAL	1.481 (.534)	.051 (.221)	1.481 (.537)	.052 (.222)

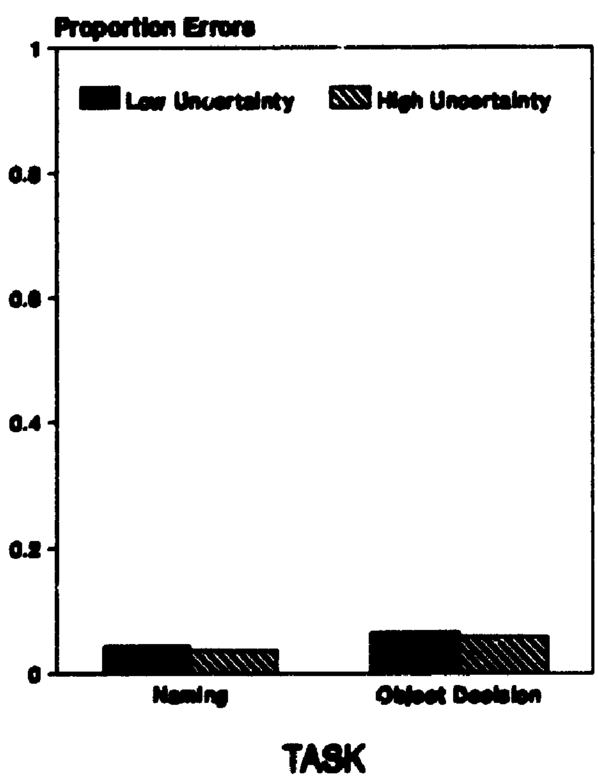
Note. Nmg = naming; OD = object decision.

[a] Results based on 19 items per uncertainty group.

[b] Results based on 20 items per uncertainty group.

Figure 4. Interaction of task and uncertainty in Experiment 1 reaction time data and corresponding error proportions for object stimuli.


Reaction Time
1.7
1.4
Low Uncertainty
High Uncertainty
Naming
Object Decision
TASK

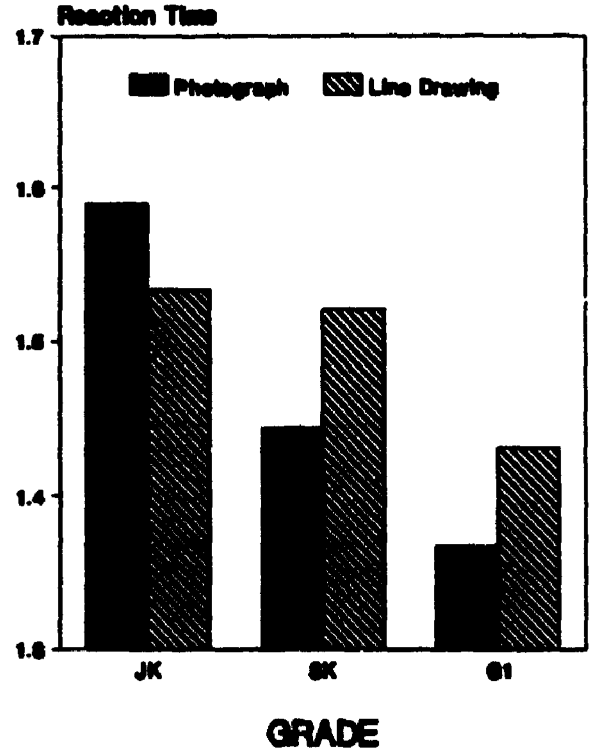

Proportion Errors
1
0.8
0.6
0.4
0.2
0
Low Uncertainty
High Uncertainty
Naming
Object Decision
TASK

longer for high uncertainty objects (M = 1.580) than for low uncertainty objects (M = 1.500), $t(59) = 4.11$, $p < .001$. Object decision RTs did not differ as a function of uncertainty (high M = 1.413; low M = 1.430), $t(59) = 1.44$, ns. The main effect of uncertainty was not significant, $F''(1,46) = 1.04$, ns.

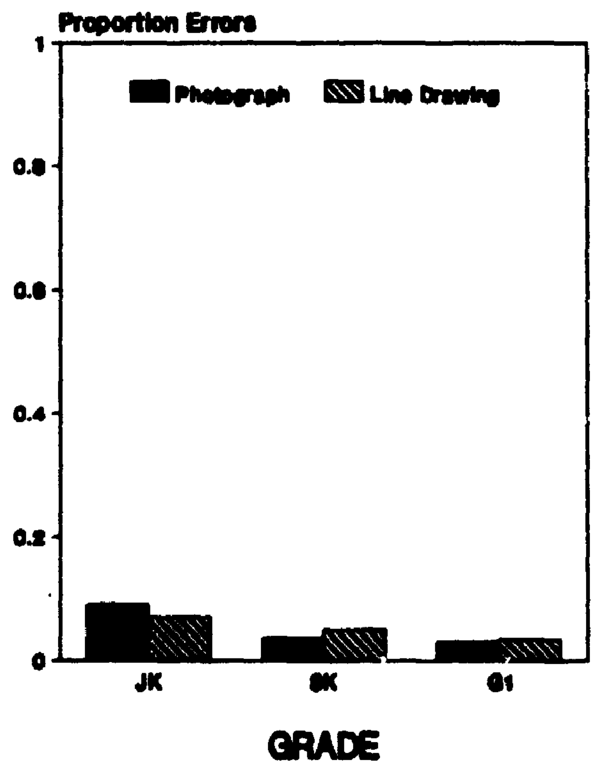
Consistent with expectations based on previous research, the main effect of task (see Figure 4) was significant, $F''(1,144) = 7.74$, $p < .01$. Responses to the naming task (M = 1.540) took longer than those for object decision (M = 1.422). In the error analysis, neither the task by uncertainty interaction nor the main effects of task or uncertainty were significant, indicating that reaction time differences were not confounded with differences in accuracy.

Effects of stimulus realism. The predicted main effect of stimulus realism was not significant, $F''(1,130) = 1.46$, ns, although the means were in the expected direction (1.467 for photographs; 1.495 for line drawings). Figure 5 illustrates the manner in which the expected main effect was qualified by a significant grade by stimulus realism interaction, $F''(2,164) = 3.85$, $p < .05$. Older children (SK, G1) showed a different pattern of reaction times to photographs and line drawings than did younger (JK) children. Older children (SK, G1) demonstrated the predicted effect of stimulus realism, responding more quickly to photographs than to line drawings of the same objects. For SK children, the RT advantage (77 msec) of photographs (M = 1.444) over line drawings (M = 1.521) was significant, $t(39) = 2.88$, $p < .01$. For G1 children, however, the advantage (64 msec) of photographs (M = 1.367) over line drawings (M = 1.431) failed to achieve significance at the designated level (p = .017, i.e., .05/3), $t(39) = 2.36$, $p < .025$.

Figure 5. Interaction of grade and stimulus realism in Experiment 1 reaction time data and corresponding error proportions for object stimuli.



Reaction Time
1.7
1.6
1.5
1.4
1.3
Photograph
Line Drawing
JK
SK
G1
GRADE



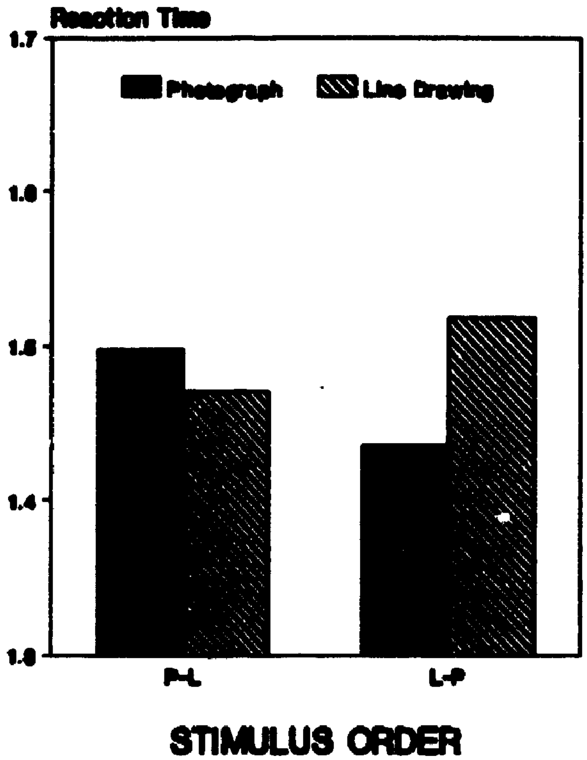
Proportion Errors
1
0.8
0.6
0.4
0.2
0
Photograph
Line Drawing
JK
SK
G1
GRADE

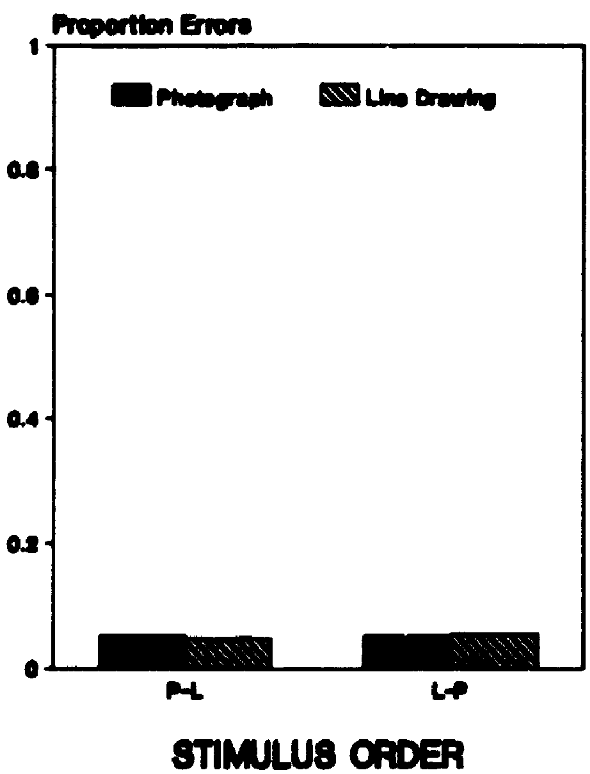
In contrast, younger children (JK) showed a non-significant trend in the opposite direction. They tended to respond more quickly to line drawings (M = 1.533) than to photographs (M = 1.589), $t(39)$ = 1.24, ns. The failure of JK children to show an RT advantage for photographs probably did not result from a speed-accuracy tradeoff, as evidenced by a corresponding pattern of means in the error data (see Figure 5). The grade by stimulus realism interaction for errors was not significant, $F < 1$, ns.

Grade also produced significant main effects (see Figure 5) in both the analyses of reaction times, $F''(2,128)$ = 5.85, $p < .01$, and errors, $F''(2,148)$ = 7.08, $p < .01$. In general, older children responded faster and more accurately than younger children. Pairwise comparisons of means revealed significant differences between the oldest (G1) and youngest (JK) children for both reaction times (G1 M = 1.399; JK M = 1.561) and errors (G1 M = .032; JK M = .080). Children in the middle age group (SK) did not differ from either the youngest or oldest children in reaction times (M = 1.483) or errors (M = .042).

Stimulus order also interacted with stimulus realism, $F''(1,135)$ = 5.43, $p < .01$, as shown in Figure 6. When photographs preceded line drawings (stimulus order P-L), there was a relatively small reaction time change (27 ms) from the first (P M = 1.498) to the second stimulus type (L M = 1.471), $t(59)$ = .86, ns. In contrast, when line drawings preceded photographs (order L-P), the RT difference from the first to the second stimulus type (83 ms) was much larger (L M = 1.519; P M = 1.436), $t(59)$ = 3.42, $p < .001$. The main effect of stimulus order on RTs was not significant. In the error analysis, neither the stimulus order by stimulus realism interaction nor the main effect of stimulus

Figure 6. Interaction of stimulus order and stimulus realism in Experiment 1 reaction time data and corresponding error proportions for object stimuli.


Reaction Time
1.7
1.6
1.5
1.4
1.3
Photograph
Line Drawing
P-L
L-P
STIMULUS ORDER


Proportion Errors
1
0.8
0.6
0.4
0.2
0
Photograph
Line Drawing
P-L
L-P
STIMULUS ORDER

order were significant.

Individual differences. Not surprisingly, individual differences among subjects accounted for significant variance in reaction times and errors, $F(108,3888) = 13.08$, $p < .0001$, and $F(108,3888) = 4.14$, $p < .0001$, respectively. Multiple regression analyses were used to assess the relations among performance measures and the individual difference variables of age, gender, and receptive vocabulary knowledge (raw scores on *Peabody Picture Vocabulary Test - Revised*). Table 7 shows the results of these regressions. High receptive vocabulary scores were associated with correct naming performance and fast RTs. Gender also contributed to prediction of correct naming, with girls outperforming boys. In object decision, vocabulary knowledge predicted correct performance, but age was most highly associated (negatively) with RTs.

Subjects also varied in their relative performance on colored photographs and line drawings, as shown by significant Subjects by Stimulus Realism interactions in both reaction times and errors, $F(108,3888) = 4.58$, and $F(108,3888) = 2.11$, $ps < .0001$, respectively. Across subjects, the degree of reaction time advantage for colored photographs was predicted by a stepwise multiple regression equation (see Table 7) that included the individual difference and task variables of correct object performance (+), stimulus order (L-P > P-L), and gender (girls > boys). The corresponding difference in errors was associated modestly with age ($r = .21$). Reaction times were also affected by the triple interaction of Subjects by Uncertainty by Stimulus Realism, $F(108, 3888) = 1.51$, $p < .001$. No subject characteristics or task variables accounted for the differences revealed by this latter interaction.

Table 7

Stepwise Multiple Regression Analyses Predicting Experiment 1 Performance on Object Stimuli from Task and Individual Difference Variables

Performance Measure / Predictor	Simple *r*	Mult. *R*	R^2 Chng.	*F*	B[a]
Correct Naming					
PPVT	.57	.57	.33	28.33***	.56
Gender	.29	.63	.07	6.54*	.26[b]
RT Naming					
PPVT	-.29	.29	.08	5.18*	-.29
Correct Object Decision					
PPVT	.46	.46	.21	15.55***	.46
RT Object Decision					
Age	-.36	.36	.13	8.81**	-.36
Correct Advantage for Colored Photographs					
Age	.21	.21	.04	5.27*	.21
RT Advantage for Colored Photographs					
Correct Objects	.28	.28	.08	9.90**	.26
Stimulus Order	.25	.38	.07	9.16**	.26[c]
Gender	.24	.[illegible]3	.04	5.77*	.20[b]

[a] Standardized regression coefficient (beta weight) in final equation.

[b] Girls > Boys.

[c] L-P order > P-I order.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Item differences. Differences among items also affected reaction times and error rates, $F(36,3888) = 8.53$, and $F(36,3888) = 4.83$, $ps < .0001$, respectively. In addition, the Items factor interacted with several experimental effects. Significant interactions were explored by multiple regression analyses that predicted item differences from the item attributes of uncertainty (DifNm, H, name stability), name AgeA, number of syllables, and color diagnosticity (color similarity, color H, and color DifNm).[2]

Item RTs varied as a function of task, $F(36,3888) = 4.29$, $p < .0001$. Consistent with theoretical expectations and earlier results, item uncertainty, as measured by H values, was the best predictor ($r = .34$) of the degree to which item naming RTs exceeded object decision RTs. The Items by Task interaction was also significant in the error analysis, $F(36,3888) = 2.40$, $p < .0001$, but the differences were not associated with any of the tested item attributes.

The effect of Stimulus Realism also varied across items, $F(36,3888) = 2.94$, $p < .0001$. One plausible explanation for this interaction centers on the distinction between objects that usually have a particular color (e.g., leaf, elephant) and those that have a variety

[2] Color diagnosticity information was obtained from adult raters ($n = 16$) in the following manner. Subjects heard the name of an object item, generated a mental image of a typical exemplar of that object, and recorded the primary color of their image. The colored slide of that object (from Experiment 1) was then presented. Subjects rated, on a 7-point scale, the degree of color similarity (1 = low; 7 = high) between their image and the presented picture. Three measures of color diagnosticity were calculated for each of the 38 object items: (a) color DifNm ($M = 4.26$, $SD = 2.00$), the number of different color names given by the group of raters; (b) color H ($M = 1.36$, $SD = .78$), a measure that takes into account the number of different color names and the proportion of subjects giving each name; and (c) rated color similarity ($M = 3.91$, $SD = 1.62$, Cronbach's alpha = .92).

of possible colors (e.g., ball, kite). Relative to objects without predictable coloration, color diagnostic objects might show a larger RT advantage when depicted by colored photographs than when depicted by line drawings. There was, however, no empirical support for this hypothesis. None of the color diagnosticity measures were associated with item differences in the degree of RT advantage for photographs.

In the RT analyses, Items also interacted with Stimulus Order, $F(36,3888) = 2.10$, $p < .001$, and with Stimulus Order by Stimulus Realism, $F(36,3888) = 2.58$, $p < .0001$. The differences revealed by these interactions were not related to available item attributes.

Additivity of effects in naming. An additional 3 (grade) X 2 (stimulus order) X 2 (uncertainty) X 2 (stimulus realism) analysis involving only the naming RTs assessed whether the effects of stimulus realism and uncertainty were additive. Such a result would suggest, by additive-factors logic (Sternberg, 1969), that the variables affect different phases of the naming operation. An interaction of stimulus realism and uncertainty would be inconsistent with the additivity hypothesis. As reported earlier, the main effect of uncertainty on naming RTs was significant. The main effect of stimulus realism, however, was not, $F''(1,87) = 2.45$, $p > .10$, (P $M = 1.514$; L $M = 1.566$). The interaction of stimulus realism and uncertainty approached, but did not reach significance, $F''(1,81) = 2.86$, $p < .10$. The RT difference between low and high uncertainty items was smaller for photographs (low $M = 1.495$, $SD = .545$; high $M = 1.532$, $SD = .572$) than for line drawings (low $M = 1.506$, $SD = .564$; high $M = 1.627$, $SD = .605$).

Analyses of Nonobject Data

The children's performance in rejecting nonobject stimuli was also of interest. Children showed more difficulty in responding correctly to nonobject stimuli than to object stimuli. Both errors (nonobject *M* = .135; object *M* = .052) and RTs (nonobject *M* = 1.776; object *M* = 1.481) reflected the additional difficulty of the nonobject rejection responses. A final series of analyses assessed the effects of the major experimental factors on nonobject rejection errors and RTs.

Statistical procedures. Nonobject errors were submitted to a 3 (grade) X 2 (task) X 2 (stimulus order) X 2 (stimulus realism) analysis of variance with repeated measures on the last factor. Subjects and items were treated as random factors.

The proportion of error responses to nonobject stimuli (.135) was too high to permit reliable estimation of missing RTs. Therefore, correct nonobject rejection RTs were submitted to separate analyses of variance based on subject means (collapsed across items) and item means (collapsed across subjects). Because these means are based on different items for different subjects, the RT results should be interpreted cautiously. Post hoc comparisons were conducted using the same procedures described earlier for the object data.

Descriptive statistics. Table 8 shows the means and standard deviations for nonobject error proportions and RTs as a function of the primary experimental factors. Figure 7 illustrates the three significant main effects (grade, task, and stimulus realism) attributable to these factors in the error analysis, as well as the corresponding effects in the RT analysis by subjects.

Effects of development. Nonobject rejection accuracy improved with advances in grade, $F''(2,141) = 10.59$, $p < .01$. The youngest children made significantly more nonobject errors (JK *M* = .213) than

Table 8

Means and Standard Deviations for Main Experimental Factors and Selected Interactions in Reaction Time and Error Analyses for Nonobject Stimuli in Experiment 1

Effect	RTs (S)[a]	RTs (I)[b]	Errors (S+I)[c]
Grade			
JK	1.925 (.464)	1.898 (.313)	.213 (.410)
SK	1.791 (.412)	1.779 (.291)	.125 (.331)
G1	1.612 (.306)	1.613 (.271)	.066 (.248)
Task			
Nmg	1.911 (.476)	1.880 (.309)	.088 (.283)
OD	1.641 (.297)	1.646 (.273)	.181 (385)
Stimulus Order			
P-L	1.694 (.359)	1.689 (.274)	.113 (.317)
L-P	1.857 (.457)	1.837 (.334)	.156 (.363)
Stimulus Realism			
Photo	1.737 (.344)	1.738 (.284)	.116 (.320)
Line	1.814 (.480)	1.788 (.341)	.153 (.360)
Stimulus Order X Stimulus Realism			
P-L Photo	1.752 (.410)	1.748 (.290)	.100 (.300)
P-L Line	1.637 (.293)	1.630 (.245)	.126 (.332)
L-P Photo	1.723 (.265)	1.727 (.278)	.132 (.338)
L-P Line	1.992 (.560)	1.947 (.350)	.181 (.385)

table continues

Effect	RTs (S)	RTs (I)	Errors (S+I)
Task X Stimulus Order X Stimulus Realism			
Nmg P-L Photo	1.912 (.438)	1.897 (.266)	.052 (.222)
Nmg P-L Line	1.721 (.317)	1.706 (.248)	.062 (.241)
Nmg L-P Photo	1.788 (.271)	1.782 (.236)	.083 (.277)
Nmg L-P Line	2.222 (.641)	2.136 (.303)	.155 (.362)
OD P-L Photo	1.592 (.311)	1.600 (.233)	.148 (.356)
OD P-L Line	1.553 (.245)	1.554 (.218)	.190 (.393)
OD L-P Photo	1.658 (.246)	1.673 (.307)	.180 (.385)
OD L-P Line	1.762 (.343)	1.757 (.287)	.207 (.405)
TOTAL	1.776 (.418)	1.763 (.314)	.135 (.341)

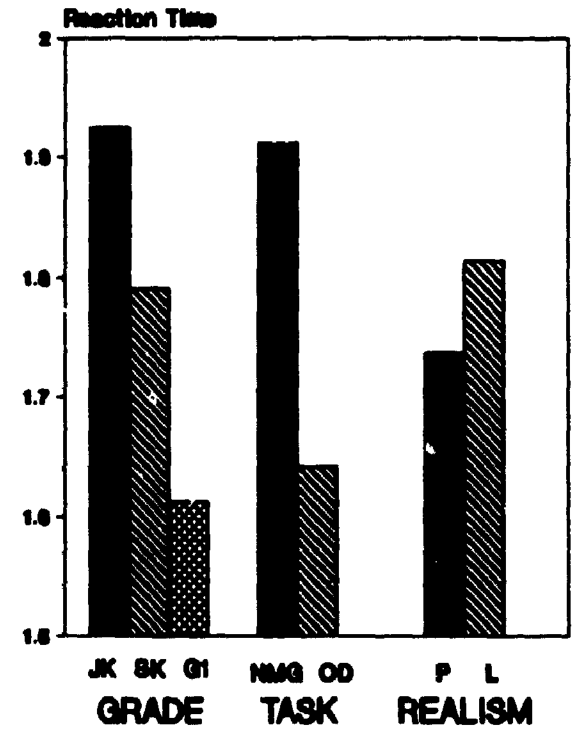
Note. Nmg = naming; OD = object decision.

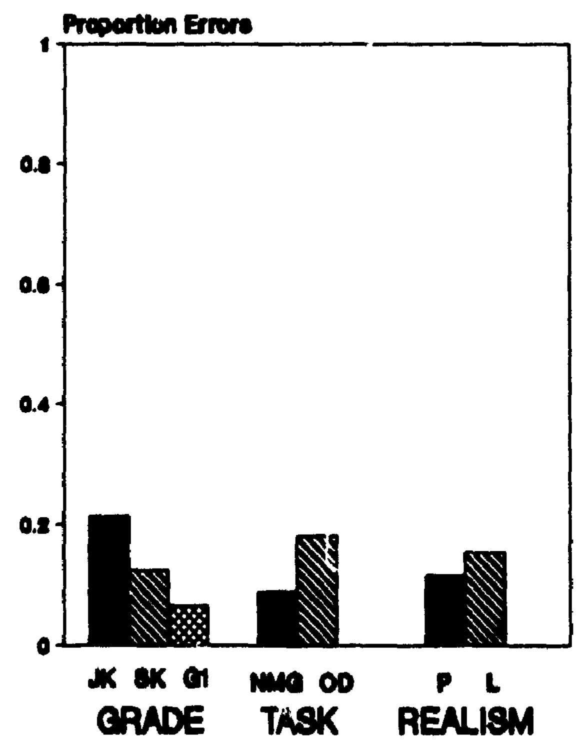
[a] Based on subject means.

[b] Based on item means.

[c] Subjects and items as random factors.

Figure 7. Main effects of grade, task, and stimulus realism in Experiment 1 reaction time and error data for nonobject stimuli.


Reaction Time
2
1.9
1.8
1.7
1.6
1.5
JK SK G1
NMG OD
P L
GRADE
TASK
REALISM


Proportion Errors
1
0.8
0.6
0.4
0.2
0
JK SK G1
NMG OD
P L
GRADE
TASK
REALISM

both groups of older children (SK M = .125; G1 M = .066). The difference in errors for SK and G1 children was not significant.

The effect of grade was also reliable in the reaction time analyses by subjects, $F(2,108) = 10.77$, $p < .0001$, and by items, $F(2,38) = 87.91$, $p < .0001$. Consistent with the error rate results, correct nonobject rejections were significantly slower for JK (M = 1.925) than for G1 children (M = 1.612). RTs for SK children (M = 1.791) did not differ significantly from those for either JK or G1 children.

<u>Effects of task</u>. Nonobject rejection accuracy also varied as a function of the task performed for the object stimuli, $F''(1,123) = 11.91$, $p < .01$. Children who made object decisions were less successful (M = .181) in rejecting nonobjects than children who named the object stimuli (M = .088). This error pattern appeared to result from a speed-accuracy tradeoff (see Figure 7). Nonobject rejections were reliably faster for the object decision task (M = 1.641) than for the naming task (M = 1.911), by subjects, $F(1,108) = 23.69$, $p < .0001$, and by items, $F(1,19) = 93.50$, $p < .0001$. In object decision, children apparently did not allow enough time for accurate nonobject judgments. The relatively impulsive nature of object decision responding, as compared to naming responding, was evidenced both in fast error RTs and frequent self-corrections. Nonobject errors occurred faster (M = 1.548) than correct responses (M = 1.665) in object decision, but slower (M = 2.725) than correct responses (M = 1.952) in naming. Self-corrections of nonobject responses occurred frequently in object decision (.267 of errors [116/435]), but far less frequently in naming (.085 of errors [18/211]).

<u>Effects of stimulus realism</u>. Stimulus realism also influenced the accuracy of nonobject rejections, $F''(1,79) = 5.76$, $p < .05$. Colored

photographs of nonobjects were rejected with fewer errors (*M* = .116) than were line drawings of the same nonobjects (*M* = .153). In the subjects analysis, reaction times showed the analogous effect, being faster for photographs (*M* = 1.737) than for line drawings (*M* = 1.814), $F(1,108) = 4.97$, $p < .05$. The means in the items analysis were in the same direction, 1.738 for photographs and 1.788 for line drawings, but the effect did not reach significance, $F(1,19) = 3.18$, $p < .10$.

Stimulus realism also entered into two significant interactions. (See Table 8 for means and standard deviations). In the RT analyses, the two-way interaction of Stimulus Order by Stimulus Realism was reliable for subjects, $F(1,108) = 30.95$, $p < .001$, and for items, $F(1,19) = 58.25$, $p < .0001$. The three-way interaction of Task by Stimulus Order by Stimulus Realism was also significant in the subjects analysis, $F(1,108) = 12.15$, $p < .001$, and the item analysis, $F(1,19) = 32.09$, $p < .0001$.

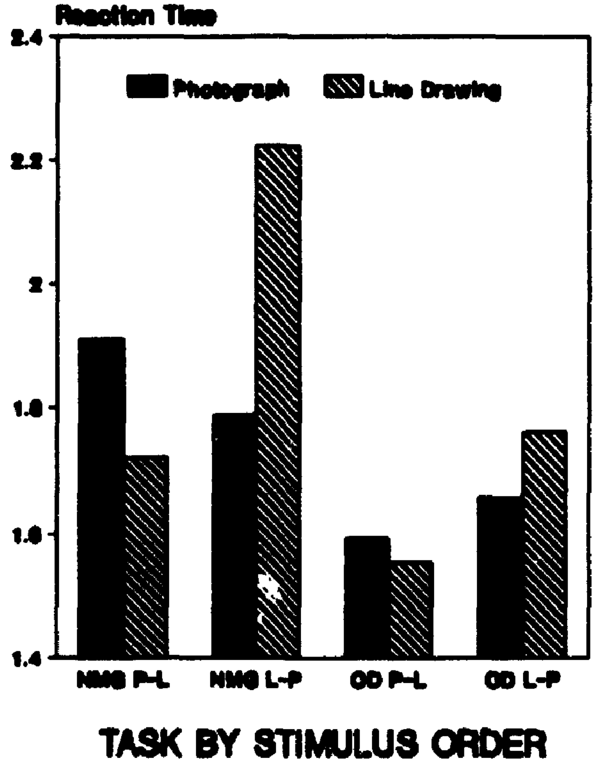
The two-way interaction of Stimulus Order and Stimulus Realism was analogous to the same interaction in the object data. The reaction time difference between the two stimulus types was larger when line drawings preceded photographs (269 ms) than when photographs preceded line drawings (115 ms). Unlike the object data, however, the RT differences were significant for both the P-L stimulus order (P *M* = 1.752; L *M* = 1.637), $t(59) = 2.88$, $p < .01$, and the L-P order (L *M* = 1.992; P *M* = 1.723), $t(59) = 4.57$, $p < .001$. In the RT data, the main effect of stimulus order was also significant by subjects, $F(1,108) = 8.66$, $p < .01$, and by items, $F(1,19) = 29.30$, $p < .0001$. Order P-L resulted in faster RTs (*M* = 1.694) than did order L-P (*M* = 1.857). Neither the Stimulus Order main effect nor its interaction with Stimulus Realism was significant in the error analysis.

The interaction of Stimulus Order and Stimulus Realism varied as a function of Task. This triple interaction is shown in Figure 8. In naming, significant RT changes occurred across stimulus types for both stimulus orders, but the magnitude of these effects was smaller for the P-L order (191 ms· P *M* = 1.912; L *M* = 1.721), *t*(29) = 3.21, *p* < .01, than for the L-P order (434 ms; L *M* = 2.222, P *M* = 1.788), *t*(29) = 4.67, *p* < .001. In object decision, the P-L order again showed a smaller RT change (39 ms) than the L-P order (104 ms). However, neither difference was significant, for P-L (P *M* = 1.592; L *M* = 1.553), *t*(29) = .78, ns, and for L-P (104 ms; L *M* = 1.762; P *M* = 1.658), *t*(29) = 1.74, ns. First trial naming responses to line drawings were particularly slow in comparison to the other means involved in this interaction. The Task by Stimulus Order by Stimulus Realism interaction was not significant in the error data.

Individual differences. As was the case for object stimuli, individual differences influenced nonobject errors, *F*(108,2052) = 6.52, *p* < .0001. Stepwise multiple regressions, shown in Table 9, revealed that correct nonobject performance was associated with age (+), task (better for naming than for object decision), and vocabulary ability (+). The interaction of Subjects and Stimulus Realism was also significant in the error data, *F*(108,2052) = 2.44, *p* < .0001. The tendency to show fewer errors for colored photographs than for line drawings was related to comprehension vocabulary scores (*r* = .20).

Because of the nature of the RT analyses, tests of effects involving Subjects were not part of the analyses of variance results. Regression analyses demonstrated that individual differences in correct

Figure 8. Interaction of task and stimulus order and stimulus realism in Experiment 1 reaction time data and corresponding error proportions for nonobject stimuli.


Reaction Time
2.4
2.2
2
1.8
1.6
1.4
Photograph
Line Drawing
NMG P-L
NMG L-P
OD P-L
OD L-P
TASK BY STIMULUS ORDER

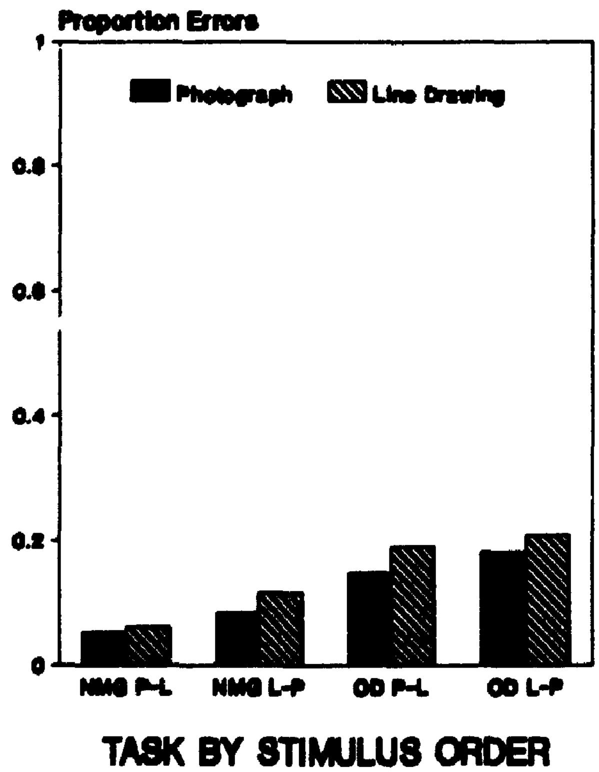

Proportion Errors
1
0.8
0.6
0.4
0.2
0
Photograph
Line Drawing
NMG P-L
NMG L-P
OD P-L
OD L-P
TASK BY STIMULUS ORDER

Table 9

<u>Stepwise Multiple Regression Analyses Predicting Experiment 1 Performance on Nonobject Stimuli from Task and Individual Difference Variables</u>

Performance Measure Predictor	Simple *r*	Mult. *R*	R^2 Chng.	*F*	B^a
Correct Nonobject Rejections					
Age	.45	.45	.20	30.12***	.32
Task	-.31	.55	[illegible]	16.21***	-.30[b]
PPVT	.42	.58	[illegible]	6.39*	.23
RT Nonobject Rejections					
Age	-.40	.40	.15	21.83***	-.39
Task	-.38	.55	[illegible]	23.87***	-.38[b]
Stimulus Order	.23	.59	.05	8.78**	.22[c]

[a] Standardized regression coefficient (beta weight) in final equation.

[b] Naming > Object Decision.

[c] L-P order > P-L order.

nonobject RTs were predicted by age (a negative relation), task (object decision faster than naming), and stimulus order (P-L faster than L-P).

Item differences. Item differences also significantly affected nonobject errors, $F(19,2052) = 8.24$, $p < .0001$. Item errors increased with the rated similarity of the nonobjects to real objects[3], $r = .49$, $p < .05$. The Items factor did not interact with other factors in error analysis.

For the nonobject RT data, Items effects could not be assessed in the analyses of variance. Item differences in RTs were positively, but not significantly, associated with the degree to which nonobjects resembled real objects, $r = .31$, ns.

Discussion

Experiment 1 compared the effects of referential uncertainty (number of acceptable object names) and stimulus realism (colored photographs vs. line drawings) on children's naming and object decision responses to the same pictured objects. Consistent with the theoretical analyses outlined earlier, referential uncertainty apparently affected a post-identification phase of naming that was not involved in object decision. In contrast, stimulus realism appeared to influence an initial perceptual phase of cognitive processing that was common to both the naming and object decision tasks. Evidence in support of these conclusions is reviewed following discussion of the validity of children's object decision responses.

[3] The same sixteen adults who rated color diagnosticity also rated, on a 7-point scale, the degree to which the nonobject stimuli resembled real objects (1 = low, 7 = high). Ratings for the 20 nonobjects averaged 3.72 ($SD = .87$, Cronbach's alpha = .77).

This experiment appears to be the first to require object decision responses from young children. At least for familiar pictured stimuli, children performed adequately in this task. Object decision responses were somewhat less accurate than naming responses, but the difference was not significant. Thus, comparisons of naming and object decision reaction times to familiar pictures were not confounded by large differences in accuracy between the two tasks.

Other evidence reinforced the validity of children's object decision responses. For example, errors were predominantly task-specific. Object stimuli were named overtly on only a small proportion (.035 or 10/286) of error trials in object decision, as compared to a much larger proportion of error trials in the naming task (.481 unacceptable names or 87/181).[4] For nonobject stimuli, the discrepancy in overt naming errors was even more pronounced (.002 or 1/435 for object decision vs. .986 or 205/208 for naming).

In addition, children's object decision responses conformed to expectations based on theory and previous adult research. Consistent with the task analyses described earlier, responses to object stimuli were slower for naming than for object decision, thereby implicating different and/or additional cognitive processes in naming. Children, like adults in previous object decision research (Kroll & Potter, 1984; Lupker, 1988), processed object stimuli faster and more accurately than nonobject stimuli. In addition, children's nonobject errors increased

[4] Other errors for object stimuli in the naming task consisted of "no" responses (.374 or 68/182), "yes" responses (.121 or 22/182), and failures to respond (.022 or 4/182). Other errors in the object decision task were "no" responses (.965 or 276/286).

with the rated similarity of nonobjects to real objects, a factor that also influences the difficulty of adult nonobject responding (Kroll & Potter, 1984). Taken together, these findings suggest that the object decision task taps similar cognitive processes in both children and adults.

The main hypothesis of this experiment received clear empirical support. Referential uncertainty affected naming but not object decision responses. Pictures with two or more acceptable names were named more slowly than those with a single dominant name. The number of acceptable names for a picture did not affect object decision times. Thus, referential uncertainty apparently affects a post-identification phase of naming (name access or generation of unique responses or both) that is not involved in object decision.

Referential uncertainty may affect naming via several possible mechanisms (Clark & Johnson, 1989; Paivio et al., 1989). One possibility is that naming is delayed by the diffusion of activation along the multiple referential pathways that connect an object representation to its various name representations (i.e., the fan effect [Anderson, 1983; Pirolli & Anderson, 1985]). A second possible mechanism involves active inhibition of all but one of the candidate names. The inhibition process would take time, thereby slowing the emergence of the eventual naming response. A third possibility is that all candidate names are accessed, but competition and eventual name selection occur during a response generation phase, perhaps again by active inhibition. These proposed mechanisms need not be mutually exclusive. In fact, all may play a role in the eventual determination of a particular naming response. One way to localize further the effect of referential uncertainty on naming may be to compare performance in verbal and nonverbal (e.g., button press) response modes, a strategy that has proven fruitful in Stroop-like tasks (Lupker & Katz, 1981; Virzi & Egeth, 1985). If referential uncertainty primarily affects name access, the reaction time difference between low and high uncertainty stimuli should be of similar magnitude for both verbal and nonverbal responses. On the other hand, if referential uncertainty primarily affects response generation, uncertainty should increase verbal, but not nonverbal reaction times.

Uncertainty effects on naming are well-documented in the literature (Butterfield & Butterfield, 1977; Clark & Johnson, 1989; Gilhooly & Gilhooly, 1979; Johnson & Clark, 1988; Lachman, 1973a, 1973b; Lachman & Lachman, 1980; Lachman et al., 1974; Mills et al., 1979; Mitchell, 1989; Paivio et al., 1989), but previous research has relied on an operational definition of uncertainty that includes both acceptable and unacceptable names for a given object. Experiment 1 is unique, therefore, in its demonstration that referential uncertainty (number of acceptable names) increases naming times over and above the uncertainty effects attributable to misidentification of the target object.

A second experimental question was whether realistic stimulus pictures (colored photographs) would permit faster naming and object decision responses than more abstract stimuli (line drawings). This predicted main effect of stimulus realism did not materialize. Rather, a significant Grade by Stimulus Realism interaction signaled a possible developmental change in the effect of stimulus realism on performance. Older children (SK, and possibly G1) showed the predicted effect, responding more quickly to photographs than to line drawings. Younger children (JK), however, showed no differences in their reaction times to photographs and line drawings. This developmental interaction suggests that reaction time differences between photographs and line drawings were not simply the result of a systematic quality difference between the two types of pictures. In addition, the absence of a significant Task by Grade by Stimulus Realism interaction indicates that, consistent with expectation, stimulus realism affected both object decision and naming in a similar fashion.

The nature of the cognitive process affected by stimulus realism cannot be determined with certainty. Two possibilities suggest themselves. The most theoretically interesting alternative is that stimulus realism affected a cognitive process central to object recognition. If so, this process would be involved in performance of a variety of everyday tasks, including object identification and naming.

If this view of the underlying process is correct, the finding that SK and G1 children process photographs more quickly than line drawings (if replicated) contradicts the suggestion by Biederman and Ju (1988) that surface characteristics, such as color and texture, do not influence object recognition. In their studies, adults named or verified the identity of objects shown for brief exposure durations as colored photographs or line drawings. Neither stimulus type showed a consistent speed or accuracy advantage across several experiments.

Alternatively, the process affected by stimulus realism could be one that is unique to tasks in which unfamiliar nonobjects must be discriminated from real objects. This possibility, although less interesting theoretically than the first, cannot be ruled out by the present data. A more thorough discussion of the possible nature and loci of stimulus realism effects will be postponed until the results of Experiment 3 are presented.

The developmental change in the effects of stimulus realism, if replicated, also suggests at least two explanations. The first explanation attributes reaction time changes to differential familiarity with the two types of pictures. Across the age range from JK to G1, children may become increasingly familiar with realistic photographs, relative to line drawings. Intuitively, the availability of various types of pictures to young children does not change as radically as is called for by this explanation.

A second possibility is that the developmental change toward an RT advantage for photographs results from increasing automatization of visual processes concerned with extraction and integration of details. For young children, processing of details in photographs may delay the extraction of critical global shape information, which is more readily accessible from line drawings. With increasing age and automatization of visual processing, detail information may become available quickly enough to facilitate processing of photographs relative to line drawings. This explanation is consistent with evidence that young children are prone to naming errors that appear to result from global visual similarities among objects (Fried-Oken, 1984; Wiegel-Crump & Dennis, 1986). The age-related decline in such errors may, in part, reflect an increase in the speed with which relevant details are extracted and utilized. Experiments in which children of different ages are required to identify photographs and line drawings following various masked exposure intervals may provide evidence concerning this explanation.

Individual object items differed in the degree to which colored photographs showed an RT advantage over line drawings. These item differences were not attributable to variations in rated color diagnosticity (i.e., the degree to which a predictable color was associated with a given object). Biederman and Ju (1988) also reported results consistent with the conclusion that a mechanism based solely on color diagnosticity cannot account for item differences in the relative advantage of colored photographs over line drawings.

Stimulus Realism also affected object reaction times by way of its interaction with Stimulus Order. Recall that all subjects responded to both photographs and line drawings in counterbalanced order. The reduction in reaction times from the first to the second stimulus type was larger when line drawings preceded photographs (order L-P) than when photographs preceded line drawings (order P-L). This asymmetry reflects the joint influence of stimulus realism (L slightly slower than P) and practice (first stimulus type slower than second). For order L-P, both realism and practice exert their influence in the same direction, resulting in a relatively large RT reduction. For order P-L, the realism effect works opposite to the practice effect, resulting in a smaller net reduction in RT. A more precise specification of practice effects might be gained by comparing the degree of RT facilitation obtained under these cross-stimulus conditions with that obtained when the same stimulus type is presented for two consecutive trials. The absence of an interaction with Task suggests that this stimulus order asymmetry affected both naming and object decision responses to objects.

To summarize up to this point, the present results are consistent with the conclusion that stimulus realism affects a stage of perceptual processing that is common to both the naming and object decision tasks used in this experiment. It remains to be determined whether this processing phase influences object recognition tasks in general or is specific to tasks that require object decisions. Further careful experimentation will be required to resolve this issue.

If stimulus realism and referential uncertainty affect different discrete phases of the naming operation, their effects on naming RTs should be additive rather than interactive (Posner, 1978; Shoben, 1982; Sternberg, 1969). Evidence concerning this hypothesis, however, was inconclusive. An interaction that approached significance suggested the possibility that, unexpectedly, uncertainty effects were more pronounced for line drawings than for colored photographs. A further test of this prediction was therefore planned for Experiment 3.

Overall, children, like adults in previous research (Kroll & Potter, 1984; Lupker, 1988), responded with more errors and longer RTs to the novel nonobject stimuli than to the familiar objects. The ease with which children correctly rejected nonobject items depended on the rated visual similarity of nonobjects to real objects. Nonobjects that were rated as visually similar to real objects were more difficult to reject than those that were dissimilar to real objects (see Kroll & Potter, 1984, for a similar result with adults).

In addition, children's correct nonobject rejection performance showed a marked speed-accuracy tradeoff as a function of the task performed for the object stimuli. Children who named object stimuli gave slower and more accurate "no" responses to nonobject stimuli than did children who made object decisions.

Several factors likely contributed to this speed-accuracy tradeoff. The speed of object decision responses, although adequate for responding to the familiar object stimuli, may have been too fast to allow children to achieve an optimal regulation of speed and accuracy for the unfamiliar nonobject stimuli. Speed-accuracy regulation is known to be problematic for young children (Brewer & Smith, 1989). In addition, the repeated use and ready availability of the two responses needed in object decision ("yes", "no") may also have fostered impulsive responding, relative to the variety of responses required in naming. Finally, an unsuccessful attempt to retrieve a name, in addition to delaying responding, may have made nonobject status more salient. Analysis of nonobject errors supported these suggestions. In object decision, nonobject errors were fast relative to correct responses and were frequently corrected. In naming, nonobject errors were slow and infrequently corrected.

The task-related differences in successful rejection of nonobjects suggest that children may not be particularly adept in making judgments solely on the basis of visual familiarity. Nonobject rejection decisions were apparently facilitated by evidence that a particular stimulus lacked a readily available name. It remains to be determined whether adults' nonobject performance would benefit similarly under naming instructions, as compared to the standard object decision conditions.

Stimulus realism also affected nonobject performance. Colored photographs of nonobjects elicited fewer errors than did their corresponding line drawings. Colored photographs also showed a reaction time advantage over line drawings. However, this advantage was reliable only in the subjects analysis and not the items analysis. Perhaps color and other surface details, such as texture, improved discrimination of nonobjects from familiar objects by allowing children to determine what materials composed the nonobjects (e.g, plastic, metal, wood). This composition information may have facilitated judgments that the depicted items were unfamiliar, i.e., nonobjects.

As was the case for object RTs, the order of stimulus presentation affected nonobject RTs through the combined influence of stimulus realism and practice. A larger reduction in RTs between stimulus types occurred when realism and practice acted in the same direction (order L-P) than when these effects acted in opposite directions (order P-L). For nonobjects, these stimulus order differences were more pronounced in the naming task than in the object decision task, perhaps because a speed-accuracy tradeoff limited the variability in object decision RTs.

A final question concerned individual differences in performance. Speed and accuracy differences among children were associated with both comprehension vocabulary knowledge and age. For object stimuli, naming speed and accuracy were most strongly associated with comprehension vocabulary scores. Comprehension vocabulary also predicted object decision accuracy, but speed of responding was better predicted by age. For nonobject stimuli, age was the best predictor of both accuracy and speed. These results suggest that, at least for naming, comprehension vocabulary growth may be one factor that underlies developmental changes in cognitive efficiency.

In summary, Experiment 1 demonstrated the empirical feasibility and theoretical value of comparing children's naming and object decision responses to the same pictured stimuli. The results encourage further use of this research strategy to investigate common as well as separate cognitive components of the two tasks.

EXPERIMENT 2

Inferences concerning the role of referential uncertainty in naming are limited by the nature of the operational definition employed in Experiment 1. In particular, individual differences in the number and strength of names associated with particular objects could not be assessed or controlled reliably because natural language materials were used. Thus, Experiment 1, as well as other studies of uncertainty in the literature, provided only correlational evidence concerning the effects of referential uncertainty on naming. Experiment 2 overcomes this problem by experimentally inducing variations in referential uncertainty for novel object-name pairs. An unfamiliar object is associated through a training paradigm with either a single name or two alternative names. If referential uncertainty reliably affects the difficulty of the naming operation, then objects associated with two alternative names should be named more slowly than those associated with just a single name. Such a result would provide strong evidence that the availability of alternative names for an object is sufficient to increase naming difficulty.

Pilot testing suggested that many children of the ages used in Experiment 1 (JK to G1) found the novel object-name learning task too difficult to complete within a single test session. Therefore, Experiments 2 and 3 used grade two (G2) children as subjects.

Method

Subjects

The subjects for Experiments 2 and 3 were grade two children from four London area public schools (different from those used in Experiment 1). Written parental consent was obtained prior to each subject's participation (see Appendix F for copies of the letter of information and parental consent form). All children spoke English as their primary language.

For Experiment 2, the analyses were based on 48 subjects (29 boys; 19 girls) who ranged in age from 6;11 to 8;6 (*M* = 7;7). Data were replaced for an additional 19 subjects (7 boys, 12 girls) because of failure to meet the name learning criterion (10 Ss) or failure to respond correctly at test in at least one experimental cell (9 Ss). Replaced subjects were slightly, but not significantly, older (*M* = 7;9) than subjects who successfully completed the experiment, $t(65) = 1.72$, ns; they also obtained lower comprehension vocabulary raw scores on the *Peabody Picture Vocabulary Test-Revised* (*M* = 81.27, *SD* = 12.93) than successful subjects (*M* = 91.71, *SD* = 10.09), $t(65) = 3.13$, $p < .01$.[1]

Design

Experiment 2 included two phases, a learning and a test phase. In the learning phase, each child learned three novel names (A, B, C) in association with two novel objects (1, 2). For each child, one novel object was paired with a single name (low uncertainty condition) and the other was paired with the other two names (high uncertainty condition). For half of the subjects, nonobject 1 was designated low uncertainty and nonobject 2 was designated high uncertainty; for the remaining half, these designations were reversed (2 = low; 1 = high). The uncertainty designations were factorially combined with the two possible orders of

[1] Because subjects for these experiments met only minimal selection criteria (appropriate grade placement; English as a primary language; no reported sensory handicaps), it is probable that some children were language and/or learning-impaired.

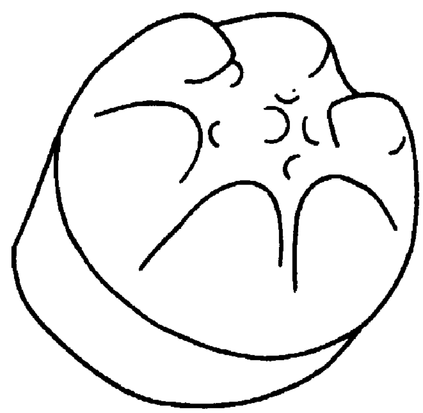
nonobject introduction (1 first, 2 second; 2 first, 1 second) to create the factor of nonobject introduction order, which included four levels. A second counterbalancing factor represented the six possible orders in which the two high uncertainty names were introduced. Two subjects were assigned randomly to each of the 24 possible combinations of nonobject introduction order and high uncertainty name order. At test, one of the subjects from each cell named colored photographs followed by line drawings (order P-L), whereas the other subject named line drawings followed by colored photographs (order L-P). Thus, the design included the three between-subjects factors of nonobject introduction order (1 high, 2 low; 2 high, 1 low; 1 low, 2 high; 2 low, 1 high), high uncertainty name order (AB; BA; AC; CA; BC; CB), and test order (P-L; L-P). Referential uncertainty (low, high) and stimulus realism (P, L) were manipulated within subjects.

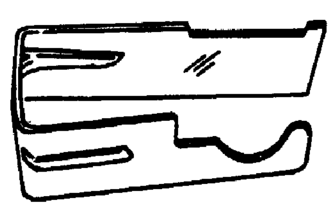
Stimuli

The experimental stimuli for the learning phase were two novel objects, which are shown in Figure 9, and three two-syllable nonsense names ("koobit" [A], "magger" [B], and "fiffin" [C]). Two additional novel objects and three real objects served as distractor stimuli during portions of the learning phase (see Procedure below).

For the test phase, each experimental novel object was drawn and photographed from two different orientations to create four test stimuli per novel object (2 line drawings; 2 colored photographs) for a total of 8 test pictures (2 nonobjects X 4 pictures each). The use of two orientations permitted subject means to be based on two rather than only one observation per cell. Pictures of four familiar objects (2 orientations X 2 stimulus types) were interspersed among the target

Figure 9. Line drawings of novel object stimuli for Experiment 2.





stimuli in the test lists. Photographs and line drawings were blocked for testing with order of blocks counterbalanced. Each object appeared once in the first half of each 12-item block and once in the second half. Two pictures of the same object did not appear in succession.

Procedure

Within a single individual test session, subjects completed three tasks in the following order: Experiment 3, Experiment 2, and comprehension vocabulary testing.[2] Experiment 2 took approximately 15-20 minutes. It was essential that children be given sufficient experience with the novel object-name pairings to enable them to name the test stimuli. In addition, it was desirable to control, at least minimally, the degree to which the names were learned across individuals. Accordingly, all children were expected to learn the target names to a criterion of three correct spontaneous productions in the presence of the target object. A dropout procedure (Underwood, 1983) was used to prevent additional exposures of names that had already been learned to criterion.

The procedure for the learning phases was as follows. First, children were asked to learn the names for each of two new things (the novel objects). The instructions and a sample presentation form are shown in Appendix G. Presentation of each novel object was accompanied by a brief auditory description in which one of the novel objects was named with a single name (low uncertainty) and one was named with two

[2] The task for Experiment 3 (naming familiar pictures) was easier than that for Experiment 2. Thus, this order of testing permitted children to experience initial success and to become familiar with the experimental apparatus prior to the more challenging name-learning experiment.

alternative names (high uncertainty). The two conditions differed only in the number of names associated with each object. During the introductory paragraphs, each name was presented four times, the final time for imitation by the child. Two more imitation trials followed. The novel objects were then placed in an open box that contained several distractors (three real objects [cup, ball, pencil] and two additional novel objects). The child's comprehension of the novel name-object pairings was assessed by having him/her point to the correct object in response to its name(s). Feedback concerning the correctness of the child's comprehension responses was given (e.g., "Good, that is the (name)." or "No, this is the (name)."). The child then repeated each name after the experimenter. A second comprehension trial was administered in the same manner as the first. At this point in the procedure, the experimenter had presented each name eleven times and the subject had imitated each four times.

The experimental objects were then presented, one at a time, for the child to name spontaneously. Feedback concerning the correctness of each name was provided as above. The real distractor objects were also included to space the interval between namings of the novel objects and to approximate the eventual test conditions. If the child correctly produced the three target names, the objects were presented a second and third time for spontaneous naming in the same manner. If all names were again produced correctly, the child proceeded to the test phase of the experiment. If errors were made, additional spontaneous naming tests involved only the name-object pairings for which the subject had not yet achieved the learning criterion of three consecutive correct spontaneous productions. The experimenter recorded the number of trials to criterion required by each child for each novel object.

During the test phase, each child was required to name slides of the novel objects, as quickly as possible. Subjects were told that they could use either name for the novel object that had two names. Slides were presented with the same apparatus used for Experiment 1. For each stimulus type (P, L), four practice slides of two familiar objects were followed by 12 test stimuli (2 orientations X 2 novel objects plus 2 orientations X 4 familiar objects). Names and latencies were recorded.

Following completion of Experiment 2, the Peabody Picture Vocabulary Test-Revised, Form L (Dunn & Dunn, 1981) was administered to each subject to obtain an estimate of comprehension vocabulary knowledge.

Results

Scoring and Timing of Responses

During testing, children often produced the target names for the novel objects with minor phonological variations. Responses containing a single variation of the following types were considered correct: (a) unstressed final syllable substitution, e.g. "koober" for "koobit"; (b) vowel change, e.g., "mugger" for "magger"; or (c) consonant change, e.g., "fibbin" for "fiffin". Phonological variations occurred on 51/384 (.133) responses to the novel objects. Of these, 33/51 (.647) were unstressed syllable substitutions, 11/51 (.216) were vowel changes, and 7/51 (.137) were consonant changes. For the most part, phonological variations reflected confusions among elements found in the other novel names. Scoring of the responses to the familiar objects and the timing of naming latencies were conducted as in Experiment 1.

Analyses of Reaction Times and Errors

Both reaction time and error analyses were conducted on subject means. Preliminary tests revealed that the factors of nonobject order (4 levels) and high uncertainty name order (6 levels) did not affect reaction times.[3] Therefore, to facilitate presentation, data were collapsed across these factors. The final analyses of variance included the between-subjects factor of stimulus order (P-L, L-P) and the within-subjects factors of object type (novel low uncertainty, novel high uncertainty, and familiar) and stimulus realism (P, L). Subjects were treated as a random factor. Posthoc tests were conducted as described in Experiment 1.

Descriptive statistics. Table 10 shows the means and standard deviations for the main experimental factors and significant interactions in the RT data. Means and standard deviations are also shown for the corresponding error data.

Effects of uncertainty. Object type significantly influenced reaction times, $F(2,92) = 41.51$, $p < .0001$, as illustrated in Figure 10. As expected, novel high uncertainty objects were named more slowly ($M = 2.215$) than novel low uncertainty objects ($M = 1.815$), $t(47) = 3.17$, $p < .01$. Not surprisingly, both low and high uncertainty novel objects were named more slowly than familiar objects ($M = 1.240$), $t(47) = 6.05$, and $t(47) = 10.24$, $ps < .001$, respectively. Object type did not interact with other factors in the RT analysis.

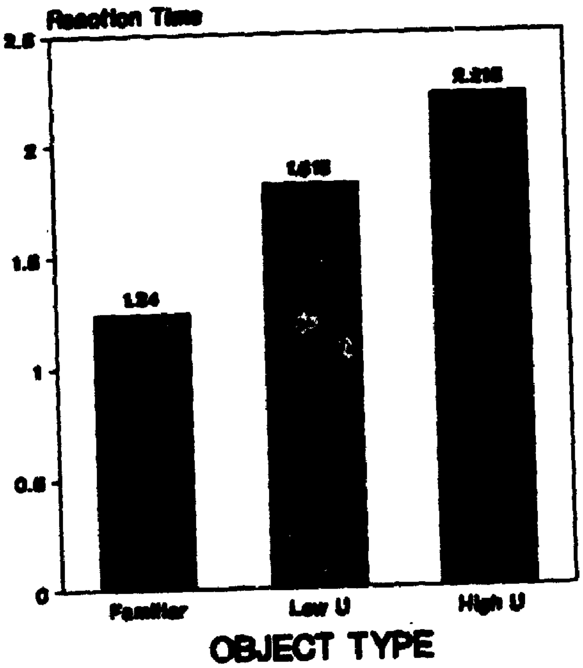
[3] In the analysis of errors, high uncertainty name order interacted with stimulus order and with stimulus order by object type. These interactions did not appear to have any interpretable significance.

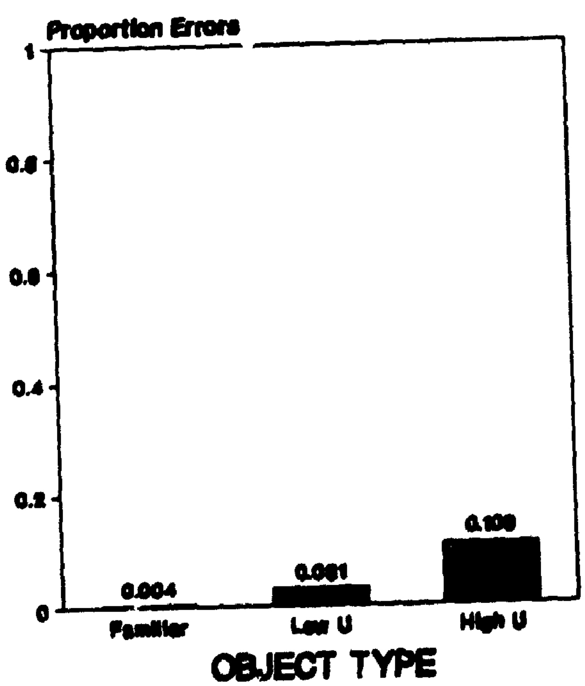
Table 10

Means and Standard Deviations for Main Experimental Factors and Selected Interactions in Reaction Time and Error Analyses for Experiment 2

Effect	RTs	Errors
Stimulus Order		
P-L	1.746 (.744)	.039 (.133)
L-P	1.767 (.912)	.057 (.158)
Object Type		
Low Uncertainty	1.815 (.773)	.031 (.122)
High Uncertainty	2.215 (.979)	.109 (.208)
Familiar	1.240 (.210)	.004 (.028)
Stimulus Realism		
Photo	1.762 (.881)	.056 (.158)
Line	1.752 (.780)	.040 (.134)
Stimulus Order X Stimulus Realism		
P-L Photo	1.831 (.812)	.043 (.139)
P-L Line	1.661 (.664)	.035 (.128)
L-P Photo	1.692 (.946)	.069 (.174)
L-P Line	1.842 (.877)	.045 (.141)
TOTAL	1.757 (.831)	.048 (.147)

Figure 10. Main effect of object type in Experiment 2 reaction time and error data.


Reaction Time
2.5
2
1.5
1
0.5
0
1.24
Familiar
Low U
High U
OBJECT TYPE


Proportion Errors
1
0.8
0.6
0.4
0.2
0
0.004
Familiar
Low U
High U
OBJECT TYPE

Consistent with the RT results, object type also affected errors, $F(2,92) = 14.57$, $p < .0001$, (see Figure 10). High uncertainty novel objects elicited a higher proportion of errors ($M = .109$) than either low uncertainty novel objects ($M = .031$), $t(47) = 3.14$, $p < .01$, or familiar objects ($M = .004$), $t(47) = 5.05$, $p < .001$. Error rates for low uncertainty novel objects and familiar objects did not differ at the designated level of significance ($.05/3 = .017$), $t(47) = 2.17$, $p < .04$. There were no other significant effects in the error analysis.

Trials to criterion. On average, subjects required somewhat fewer trials to reach the name learning criterion (three consecutive correct spontaneous productions) for low uncertainty objects ($M = 4.10$, $SD = 1.37$) than for high uncertainty objects ($M = 4.40$, $SD = 1.61$), but this difference was not significant, $t(47) = 1.15$, $p > .25$. Across subjects, differences in trials to criterion for low and high uncertainty items were not related to differences in reaction times for those same items, $r = -.01$, ns.

Effects of stimulus realism. Reaction times to colored photographs ($M = 1.762$) and line drawings ($M = 1.752$) did not differ significantly, $F(1,46) < 1$. However, as in Experiment 1, stimulus realism interacted with stimulus order, $F(1,46) = 4.68$, $p < .05$. For both stimulus orders, reaction times were longer for the first stimulus type than for the second. Decreases in reaction times from the first to the second stimulus type were not significant for order P-L (P $M = 1.831$, L $M = 1.661$), $t(23) = 1.69$, ns, or for order L-P (L $M = 1.842$, P $M = 1.692$), $t(23) = 1.38$, ns. No other effects were significant in the reaction time analysis.

Individual differences. For the 48 final subjects, individual differences in naming reaction times were not significantly associated with age or comprehension vocabulary scores. Correct performance on the novel object test stimuli tended to be related positively to comprehension vocabulary knowledge, $r = .22$, $p < .07$, but was related negatively to age, $r = -.34$, $p < .01$. A few older children who made errors appeared to account for the latter result. Production of phonological variations for target names was not related to age or vocabulary scores.

Discussion

The referential uncertainty manipulation employed in Experiment 2 provides powerful evidence that the availability of multiple names for a given object is sufficient to increase naming difficulty. Previous studies of uncertainty (including Experiment 1) have used correlational methodologies which do not permit rigorous experimental control of possible confounding factors, such as the frequency with which subjects have encountered the target objects and their names. Experiment 2 controlled these and other factors, thereby permitting greater confidence in the conclusion that referential uncertainty increases naming difficulty.

In the ideal case, all Experiment 2 subjects would have achieved the name learning criterion following equal exposure to the names for both low and high uncertainty objects. In reality, individual children sometimes required more trials to reach criterion for one of the objects than for the other. Importantly, these differences in trials to criterion were not responsible for the naming reaction time differences between low and high uncertainty test stimuli.

Referential connections probably acquire strength in proportion to the frequency with which the relevant object-name pairings are experienced. Under this assumption, the equal exposure of the high uncertainty names in this experiment should have resulted in equivalent referential strengths for the two names, and therefore maximal competition among them. A possible direction for further research would be to vary systematically the input frequency for two (or more) alternative names. A difference in input frequency should promote dominance of the more frequently-heard alternative, thereby reducing competition among the names and resulting in faster reaction times than the case where input frequency is equated. Such demonstrations would further our understanding of the presumed relation between input contingencies and the relative strengths of multiple name responses for particular objects.

Input and/or practice factors also appear to be responsible for the finding that children named familiar objects more quickly than either the low or high uncertainty novel objects. This naming speed advantage for familiar objects was robust and was not overcome by the recency and intensity of exposures to the novel object-name pairings.

One limitation on the generalizability of the present results is that more than one-quarter of the children tested (19/67 or .28) were unable to provide useable data, either because of failure to meet the learning criterion or failure to remember the target names at test. As a group, unsuccessful subjects had significantly lower comprehension vocabulary scores than successful subjects. Thus, it appears that the processes or abilities that support vocabulary acquisition in the natural language context also influence performance in novel name learning situations.

Some children experienced difficulties in stabilizing the exact phonological forms appropriate for the novel names. Unstressed final syllables were particularly likely to be replaced with a final syllable appropriate to another novel name within the experiment. Similar phonological variations have been noted in other experiments in which children learned to produce multiple novel names within a single context (Masters & Duchan, 1989).

In this experiment, colored photographs and line drawings were named with equal proficiency, as shown by the lack of a main effect of stimulus realism for both RTs and errors. Discussion of this result will be postponed until after the results of Experiment 3 are presented.

In conclusion, this study constitutes the first experimental manipulation of referential uncertainty. Replication and extension of these findings will further delineate the boundaries of the phenomenon.

EXPERIMENT 3

The primary purposes of Experiment 3 were to replicate the uncertainty results from Experiment 1 and to demonstrate that the same subjects who showed referential uncertainty effects for novel object-name pairs in Experiment 2 would also show similar effects with natural language materials. An additional purpose of Experiment 3 was to assess further the possible influence of stimulus realism (colored photographs vs. line drawings of the same objects) on naming RTs.

Method

Subjects

A total of 74 grade two children (38 boys, 36 girls) completed Experiment 3. Of these, 67 had also participated in Experiment 2. Seven additional subjects were tested to complete the experimental design. The main analyses for Experiment 3 are thus based on 72 subjects (37 boys, 35 girls), who represented nine replications of the experimental conditions (9 replications X 4 stimulus lists X 2 stimulus orders). These subjects ranged in age from 6;7 to 8;6 (*M* = 7;7). Where appropriate, Experiment 3 results are also reported for the 48 subjects (6 replications) who successfully completed Experiment 2. The design for Experiment 3 included referential uncertainty (low, high) and stimulus realism (photographs [P], line drawings [L]) as within-subjects factors and stimulus order (P-L, L-P) as a between-subjects factor.

Naming Stimuli

The naming stimuli were the same object pictures used in Experiment 1, with the exception that "bed" was substituted for "apple" in the low uncertainty group. Slides of line drawings and colored photographs of 40 single objects (20 low uncertainty; 20 high uncertainty) were the target stimuli. Photographs and line drawings of eight additional objects served as practice stimuli.

Stimulus Lists

Target items were assigned randomly to four blocks of ten items each. Four different list orders were constructed so that each block of items appeared once in each possible list position. Each child received the same list order for both P and L trials, but the random ordering of items within each block was different for each stimulus type (P or L). Nine children in each stimulus order cell were randomly assigned to each of the four stimulus lists.

Procedure

The Experiment 3 portion of the test session lasted approximately 5-10 minutes. Each child was instructed to name the object stimuli as quickly as possible. Eight practice items preceded the 40 test trials for the first stimulus type (either P or L). The practice and test trials for the second stimulus type were then presented in a similar fashion. Presentation of stimuli, recording of responses, calculation of uncertainty measures, and timing of latencies were accomplished in the same manner as for Experiment 1.

Results

The presentation of results begins with a summary of uncertainty measures based on the Experiment 3 responses. Analyses of naming RTs (and errors) then address the primary questions of the experiment, with analyses of subject and item differences complementing the main results.

Uncertainty Measures

Table 11 presents descriptive statistics and intercorrelations for the item uncertainty measures derived from the responses of Experiment 3

Table 11

Descriptive Statistics and Correlations among Uncertainty Measures for Low and High Uncertainty Item Groups in Experiment 3

Uncertainty Measure	2	3	4	5	M	SD
Low Uncertainty (n = 20 items)						
1 DifNm (P)	.80	.93	.72	-.73	2.55	2.14
2 DifNm (L)	---	.90	.89	-.67	2.30	1.69
3 H (P)		---	.92	-.86	.21	.30
4 H (L)			---	-.89	.20	.29
5 Name Stability (items)				---	.96	.06
High Uncertainty (n = 20 items)						
1 DifNm (P)	.85	.72	.65	-.36*	3.95	1.43
2 DifNm (L)	---	.67	.71	-.47	4.00	1.38
3 H (P)		---	.97	-.76	.88	.40
4 H (L)			---	-.79	.86	.42
5 Name Stability (items)				---	.87	.06
All (N = 40 items)						
1 DifNm (P)	.84	.78	.69	-.64	3.25	1.93
2 DifNm (L)	---	.82	.82	-.70	3.15	1.75
3 H (P)		---	.97	-.88	.55	.49
4 H (L)			---	-.89	.53	.49
5 Name Stability (items)				---	.92	.08

* not significant, p < .05.

subjects. The uncertainty results from Experiment 3 replicated those of Experiment 1 (see Table 5) in all important respects: (a) the various inter-individual and intra-individual uncertainty measures correlated significantly with each other, suggesting that they measure a similar underlying construct; (b) objects in the high uncertainty group exceeded those in the low uncertainty group on all measures of uncertainty, $t(38)s > 2.42$, $ps < .022$, thus confirming the object classifications; and (c) colored photographs and line drawings did not differ in uncertainty, all $t(40)s < 1.09$, $ps > .28$, demonstrating that stimulus realism and uncertainty were not confounded.

Analyses of Reaction Times and Errors

Naming errors were rare in Experiment 3 (72/5760 or .013). As in Experiment 1, RTs for correct responses were truncated at +3 *SD*s and RTs for error responses were estimated using the procedure recommended by Myers (1979). Truncation affected 74 naming responses (.013). RTs and errors were analyzed in separate 2 (stimulus order) X 2 (uncertainty) X 2 (stimulus realism) analyses of variance with subjects (nested in stimulus order) and items (nested in uncertainty) treated as random factors. Quasi-*F* tests and subsequent posthoc tests were conducted as described in Experiment 1.

Predictions. The primary prediction was that low uncertainty pictures would be named more quickly than high uncertainty pictures. Of secondary interest was the question whether realistic pictures (colored photographs) would be named more quickly than abstract pictures (line drawings).

Descriptive statistics. Table 12 shows the means and standard deviations for the main experimental factors and selected interactions

Table 12

Means and Standard Deviations for Main Experimental Factors and Selected Interactions in Naming Reaction Time and Error Analyses for Experiment 3

Effect	RTs (72)[a]	Errors (72)[a]	RTs (48)[b]	Errors (48)[b]
Stimulus Order				
P-L	1.334 (.456)	.015 (.121)	1.296 (.422)	.014 (.116)
L-P	1.289 (.402)	.010 (.100)	1.263 (.370)	.007 (.085)
Uncertainty				
Low	1.269 (.398)	.013 (.111)	1.247 (.381)	.012 (.109)
High	1.354 (.457)	.013 (.111)	1.312 (.410)	.009 (.094)
Stimulus Realism				
Photo	1.307 (.445)	.013 (.113)	1.283 (.413)	.011 (.104)
Line	1.316 (.416)	.012 (.110)	1.276 (.381)	.010 (.099)
Stimulus Order X Stimulus Realism				
P-L Photo	1.366 (.485)	.017 (.128)	1.327 (.445)	.016 (.124)
P-L Line	1.302 (.424)	.013 (.114)	1.265 (.396)	.011 (.106)
L-P Photo	1.249 (.392)	.009 (.095)	1.239 (.373)	.006 (.079)
L-P Line	1.329 (.407)	.011 (.105)	1.287 (.366)	.008 (.091)
TOTAL	1.312 (.430)	.013 (.111)	1.280 (.397)	.010 (.102)

[a] Analysis based on 72 subjects.

[b] Analysis based on 48 subjects.

in the RT and error data for the 72 Experiment 3 subjects. Comparable statistics are shown separately for the 48 subjects who successfully completed Experiment 2. Separate analyses were conducted for the 72-subject and 48-subject data, but because the results were similar, only the analyses for the full 72 subjects are reported.

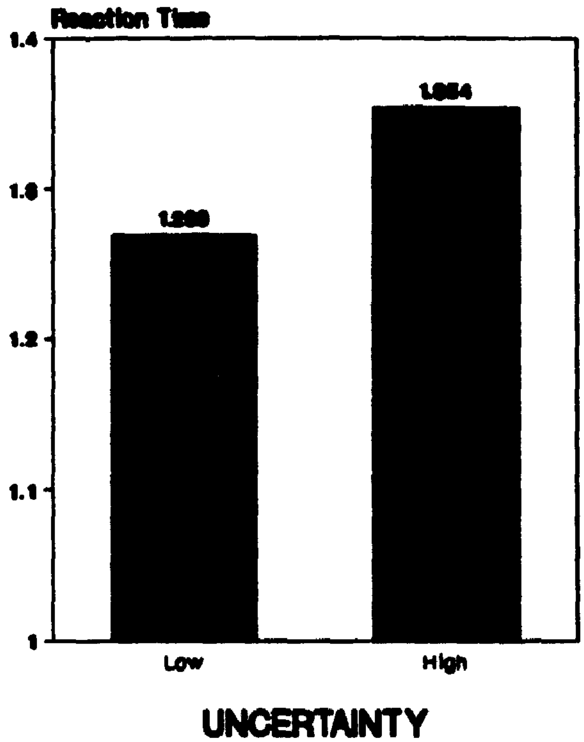
Effects of uncertainty. Consistent with expectation, referential uncertainty exerted a significant influence on naming RTs, $F''(1,45) = 4.33$, $p < .05$. As illustrated in Figure 11, low uncertainty pic .s ($M = 1.269$) yielded faster naming RTs than high uncertainty pictures ($M = 1.354$). Error rates were not affected by uncertainty, $F'' < 1$. In addition, there were no significant interactions involving uncertainty in either the RT or error analyses.

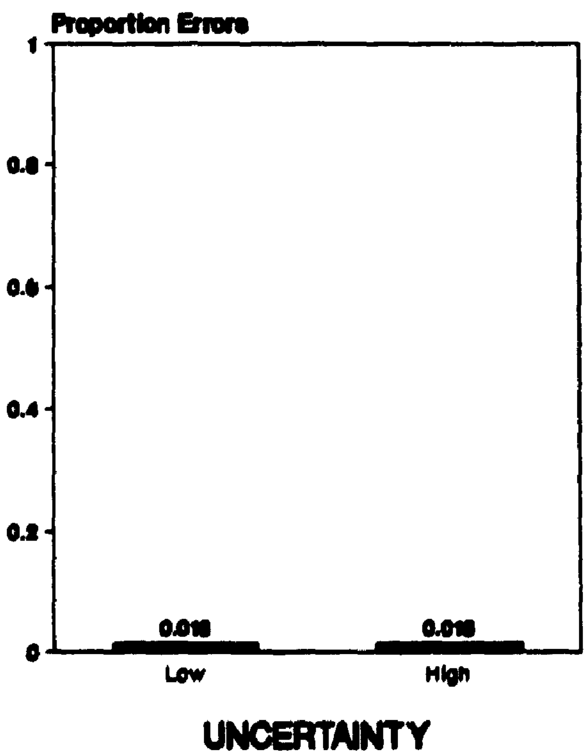
Effects of stimulus realism. There was no evidence for a main effect of stimulus realism on either naming RTs or errors, $Fs'' < 1$. The difference in reaction times for colored photographs ($M = 1.307$) and line drawings ($M = 1.316$) was only 9 ms.

As in Experiments 1 and 2, stimulus realism interacted with stimulus order. For both orders, reaction times for the first stimulus type were significantly longer than for the second type, for order P-L (P $M = 1.366$; L $M = 1.302$), $t(35) = 2.36$, $p < .05$, and for order L-P (L $M = 1.329$; P $M = 1.249$), $t(35) = 5.56$, $p < .001$. The stimulus realism by stimulus order interaction was not significant in the error analysis. Stimulus order did not exert a main effect on either RTs or errors.

Individual differences. Differences among subjects affected naming RTs, $F(70,2660) = 12.16$, $p < .0001$, but not errors (probably b. ause error rates were so low overall). The variability in RTs was not related to the subject characteristics of age, gender, or

Figure 11. Main effect of uncertainty in Experiment 3 reaction time and error data.


Reaction Time
1.4
1.1
1
Low
High
UNCERTAINTY


Proportion Errors
1
0.2
0
Low
High
UNCERTAINTY

comprehension vocabulary scores. These characteristics were also unrelated to individual differences in the magnitude of the uncertainty effect.

Subjects also varied in their relative performance on colored photographs and line drawings, as shown by a significant Subjects by Stimulus Realism interaction for RTs, $F(70,2660) = 3.10$, $p < .0001$. Regression analyses revealed that these stimulus realism differences were primarily attributable to the task variable of stimulus order, multiple $R = .49$.

Item differences. Item differences affected both RTs, $F(38,2660) = 13.40$, $p < .0001$, and errors, $F(38,2660) = 2.60$, $p < .0001$. In addition, the Items factor interacted with several other experimental effects. These significant interactions were explored with regression analyses using item attributes as predictors.

The effects of stimulus realism varied across items, as indicated by significant Items by Stimulus Realism interactions for both RTs $F(38,3660) = 3.63$, $p < .0001$, and errors, $F(38,2660) = 1.89$, $p < .001$. As in Experiment 1, these item-specific differences between colored photographs and line drawings were not associated with the color diagnosticity of the depicted object or with other available item attributes.

The triple interaction of Stimulus Order by Stimulus Realism by Items was also significant for RTs, $F(38,2660) = 2.20$, $p < .0001$, but not for errors. Differences revealed by this interaction were not related to any of the tested item attributes.

Stability of item differences across experiments. Several additional analyses assessed the stability of item differences across

Experiments 1 and 3. Item naming RTs were highly correlated across experiments, $r = .77$, $n = 39$, $p < .001$, as were item errors, $r = .46$, $p < .01$. In addition, item differences in RTs to colored photographs and line drawings were correlated, $r = .36$, $p < .01$. Thus, item characteristics appeared to exert a similar influence on naming performance in both experiments.

Discussion

Consistent with prior results, Experiment 3 yielded a reliable effect of referential uncertainty on naming RTs. Pictures with multiple possible names were named more slowly than those with a single dominant name. This uncertainty effect for natural language materials was evidenced by the same children who showed an effect of experimentally induced uncertainty in Experiment 2. Across experiments that involved the same familiar object pictures, the magnitude of the uncertainty effect was similar, 80 ms (effect size .15) in Experiment 1 and 85 ms (effect size .21) in Experiment 3.

Similarities across experiments were also apparent in children's naming performances on individual object items. Item-specific differences in naming speed were particularly stable across experiments, but some consistency was also noted for accuracy (despite limited variability) and for the relative effects of stimulus realism. In general, such results confirm the importance of item attributes as determinants of naming performance.

In Experiments 2 and 3, G2 children did not show a main effect of stimulus realism on naming RTs or errors. Colored photographs and line drawings of the same objects were named with equal proficiency. This result conflicts with earlier evidence that somewhat younger (SK and G1) children named colored photographs more efficiently than line drawings. If none of the results represent sampling errors, then two possible reconciliations of the findings hinge on developmental and task differences, respectively.

The first possibility is that children in the age range from SK to G2 become increasingly adept at naming abstract pictures relative to realistic ones. The initial naming RT advantage for photographs over line drawings would therefore decrease and eventually disappear with development. This hypothesized developmental sequence is consistent with some evidence. For example, the RT advantage for photographs in Experiment 1 was significant for SK children, but only marginally so for slightly older G1 children. In Experiments 2 and 3, still older G2 children showed no such advantage. In addition, some evidence suggests that adults show no reliable naming differences between photographs and line drawings (Biederman & Ju, 1988).

The primary difficulty encountered by this developmental explanation is the fact that the youngest children tested (JK in Experiment 1) also showed no reliable naming advantage for realistic stimuli. To maintain the developmental change hypothesis, it would be necessary either to discredit this JK result or to argue for a rather implausible sequence of developmental changes. Such a sequence would involve an initial phase in which children process realistic and abstract stimuli with equal ease, followed by a period in which a processing asymmetry favors realistic pictures. At the third (presumably final) stage, equal proficiency for both types of stimuli would again be attained. Although not logically impossible, there seems to be no compelling reason to propose such a complex developmental course.

Task differences may also be responsible for the conflicting effects of stimulus realism on naming performance in the two experiments. In Experiment 1, the subjects who named familiar pictured objects were also required to reject pictures that showed unfamiliar nonobjects. In short, an object decision task was embedded within the naming task. The need to discriminate nonobjects from real objects may have introduced the use of a cognitive process that is not regularly employed in normal naming situations (e.g., Experiments 2 and 3). This additional process may be sensitive to stimulus realism. For example, details such as color and texture may permit a subject to decide rapidly whether a pictured object is familiar or not. Alternately, the absence of such details may force a subject to postpone a decision until additional evidence accumulates or until initial evidence is re-evaluated. In assessing object familiarity, young children (such as the JKs in Experiment 1) may not be able to make efficient use of the additional cues offered by realistic pictures. Slightly older children, however, can use these additional details to facilitate object decision.

This hypothesized task-specific explanation reconciles the discrepancy in the effects of stimulus realism across experiments. It also accounts for the fact that stimulus realism affected nonobject rejection performance in Experiment 1. Colored photographs of nonobjects were rejected more accurately than line drawings, as would be expected under this explanation.

Given available data, it is not possible to make a definitive decision between the developmental and the task-specific explanations for the stimulus realism effects found across these experiments. To do so will require a direct comparison of the performance of children of various ages on naming tasks with and without nonobjects.

GENERAL DISCUSSION

This research demonstrated definitively that referential uncertainty (the existence of multiple possible names for an object) increases the difficulty of a post-identification phase of naming. Across three experiments employing different methodologies, objects with multiple possible names were named more slowly than objects with a single dominant name. Although others have suggested a similar conclusion (e.g., Lachman & Lachman, 1980), various methodological aspects of the current studies greatly strengthen the evidence in support of such a claim.

Most importantly, the current research went beyond previous correlational studies to provide the first experimental evidence that referential uncertainty increases naming difficulty. The novel object-name learning task used in Experiment 2 permitted control over factors whose effects cannot be teased apart from those of referential uncertainty when natural language materials are used. For example, Experiment 2 controlled the input frequency for target names, the assignment of objects to uncertainty conditions, and the order in which objects and names were introduced. In addition, the use of a specific learning criterion ensured that each subject acquired at least a minimal degree of object-name knowledge. Thus, the robust difference in Experiment 2 naming RTs for low and high uncertainty objects can be attributed confidently to the number of possible names associated with each object.

The current experiments involving natural language materials also incorporated methodological improvements relative to previous research.

For example, several procedures helped to insure that uncertainty effects were attributable to the existence of multiple possible names and not to misidentifications of the target objects or other possible confounds: (a) uncertainty classifications were determined by the number of possible <u>acceptable</u> names for a particular picture, rather than by the total number of names (both acceptable and unacceptable); (b) pre-testing insured that both low and high uncertainty objects were familiar to young children and were rarely misidentified; and (c) uncertainty groups were matched on two name-word characteristics known to affect naming performance, age of acquisition and number of syllables. The success of these procedures was reflected in the low overall error rates (.05 in Experiment 1; .01 in Experiment 3) and the consistent lack of error differences between low and high uncertainty items. Thus, it is highly plausible that the uncertainty differences noted in Experiments 1 and 3 arose at a post-identification phase of naming.

A post-identification locus for referential uncertainty was also indicated by the finding that uncertainty did not influence performance in object decision, a task assumed to require primarily object identification processes (Kroll & Potter, 1984; Lupker, 1988; Schacter, Cooper, & Delaney, 1990). This result is important because the object decision task, like naming, does not permit anticipation of the visual characteristics of the upcoming stimulus. Previous reports that uncertainty did not affect perceptual identification (Lachman & Lachman, 1980) were based on matching tasks that may permit subjects to anticipate stimulus characteristics on the basis of a previously-presented name or picture.

The current research also provided some new information concerning developmental issues related to referential uncertainty. For example, comparisons of inter-individual (DifNm and *H*) and intra-individual (name stability) measures of uncertainty validated the important assumption that group measures of uncertainty estimate the uncertainty of referential connections for individual children. Similar results have been reported previously for adults (Johnson & Clark, 1988; Paivio et al., 1989).

With maturation, children may become increasingly adept at implementing inhibitory processes (Clark & Johnson, 1989; Johnson & Clark, 1988; Tipper, Bourque, Anderson, & Brehaut, 1989). If the referential uncertainty effect implicates such processes, its magnitude might decline with increasing age. The current experiments provided some preliminary (albeit rather weak) tests of this hypothesis. There was no indication that the magnitude of the uncertainty effect varied with development, as evidenced by the absence of a Grade X Uncertainty interaction in Experiment 1, and the lack of significant correlations between age or comprehension vocabulary scores and uncertainty differences across subjects in all three experiments. Unfortunately, none of the experiments permitted a particularly sensitive test of this question. The primary difficulty is that there is no way to determine the degree to which subjects experience competition among alternative names for a given item. For example, improvements in inhibitory skill may be counteracted by developmental increases in the strength of alternative names. Because it permits control of a number of relevant factors, the novel object-name paradigm used in Experiment 2 may be useful in determining whether uncertainty effects change with development.

Several other key issues concerning referential uncertainty remain to be resolved. The present demonstration of a post-identification locus for uncertainty leaves open the possibility that these effects arise at a name access phase, a response generation phase, or both. As suggested earlier, comparisons of uncertainty effects across verbal and nonverbal response modes may provide data concerning this issue.

A related question is whether the mechanism responsible for referential uncertainty effects involves passive diffusion of activation over multiple referential pathways or active inhibition among candidate names. Finding an appropriate paradigm to address this question will likely be a challenging task. Most successful demonstrations of inhibition effects have used Stroop-like tasks that involve presentations of two external stimuli, a target and a distractor (e.g., Glaser & Glaser, 1989; Tipper, 1985; Tipper & Cranston, 1985; Tipper & Driver, 1988). Such manipulations do not apply in the case of referential uncertainty because a single stimulus object or picture generates both the eventual name response and the to-be-inhibited alternatives. In this sense, the mechanism underlying referential uncertainty may be similar to that responsible for the activation of multiple meanings during the reading of ambiguous words (Gernsbacher, 1989; Seidenberg, Tanenhaus, Leiman, & Bienkowski, 1982; Swinney, 1979). Adaptation of paradigms used to study ambiguous word phenomena may therefore be useful in further study of referential uncertainty.

A final question concerns the role of context in determining a speaker's choice among alternative names for a given object (Carroll, 1985; Olson, 1970). Presumably, there are few, if any, cases where various alternative names are entirely synonymous (Clark, 1988; Gathercole, 1989). One name may be preferred over another if a speaker judges that it more effectively discriminates an intended referent from other possible referents considered by a listener (Olson, 1970). Such contextual influences probably played a minimal role in the current picture naming experiments because the intended referent was clear to both the speaker (child) and listener (experimenter). It would be interesting, however, to determine the degree to which children's name selections and naming reaction times for a particular high uncertainty object vary as a function of context (e.g., picture of tricycle in context of cow and pencil vs. picture of tricycle in context of motorcycle and bicycle). Such data might help to further specify the mechanisms underlying referential uncertainty effects.

In concluding this section, it is relevant to point out that the present referential uncertainty results can likely be accommodated by most current models of cognitive functioning (e.g., Anderson, 1983; Morton, 1979). The findings, however, are particularly compatible with certain models of naming and language acquisition that emphasize the probabilistic nature of mental connections among representations. The dual coding model of naming (Paivio, 1971, 1986), for example, explicitly incorporates the assumption that object and name representations are connected bidirectionally in a one-to-many fashion. Competition among representations that vary in strength is also a central tenet of the language acquisition model proposed by MacWhinney (1987).[1] The concept of referential uncertainty is also compatible with theoretical views that model language behavior in terms of non-cognitive constructs, such as stimulus-response competition (Skinner, 1957) and informational uncertainty (Shannon & Weaver, 1949). In short, referential uncertainty applies to naming behavior as viewed from a variety of perspectives.

Stimulus realism yielded inconsistent effects on naming and identification tasks across the current experiments. In Experiment 1, SK and G1 children responded more quickly to realistic colored photographs than to more abstract line drawings of the same objects in both naming and object decision. In contrast, JK children in Experiment 1 and G2 children in Experiments 2 and 3 showed equal reaction times for realistic and abstract stimuli.

Other experiments involving naming and identification tasks have also reported inconsistent effects of stimulus realism. Biederman and Ju (1988) found no consistent differences in adults' reaction times for colored photographs and line drawings across a series of identification and naming tasks. Ostergaard and Davidoff (1985), however, reported

[1] In fact, MacWhinney (1989) has recently outlined how competition among multiple names for an object may motivate behaviors that have been taken as evidence for children's bias to maintain mutual exclusivity of reference in learning object names (Markman, 1989; Merriman & Bowman, 1989). MacWhinney argues that language learners, when possible, attempt to minimize competition among alternative names for an object by: (a) assuming that a novel name refers to an unfamiliar object rather than to an object with a known name, (b) refusing to accept an alternative name for an object with a known label; or (c) distinguishing separate contexts in which the known and novel names may be applied to the same object. The present results suggest that these hypothesized operations do not entirely eliminate competition among alternative names for a given object.

that adults named colored pictures faster than uncolored ones, but that color did not influence object recognition when it was an unreliable cue to object identity.

Pending further experimentation, the following tentative conclusions are offered concerning the effects of stimulus realism on picture identification and naming. First, as suggested by Biederman and Ju (1988), there appears to be little compelling evidence that realistic picture details necessarily facilitate the extraction of the global shape information that is obligatory for object recognition or naming. This conclusion is supported by the present Experiment 2 and 3 results, as well as by the identification and naming results of Biederman and Ju (1988) and the recognition results of Ostergaard and Davidoff (1985). Second, color and/or other realistic details may augment global shape information under conditions where the latter is insufficient for accurate performance. For example, the naming stimuli used by Ostergaard and Davidoff (1985) were pictures of fruits and vegetables, two categories in which there is high visual similarity among exemplars in terms of global shape (Snodgrass & McCullough, 1986). The additional information provided by colored pictures thus improved naming performance. In the present Experiment 1, attention to color and detail cues likely facilitated the discrimination between pictures of familiar objects and unfamiliar nonobjects. Older children were able to take advantage of such cues whereas the younger children were not.

Task-specific demands may also be responsible for the conflicting results of stimulus realism in the memory recall and recognition literature (Mazzoni, Cavedon, & Davidoff, 1988). As in naming and perceptual identification tasks, some recognition memory paradigms have yielded no differences between stimuli that vary in realism (Dirks & Neisser, 1977; Nelson, Metzler, & Reed, 1974), whereas others have yielded advantages for realistic stimuli (Homa & Viera, 1988; Loftus & Bell, 1975; Mazzoni, Cavedon, & Davidoff, 1988) or even for abstract stimuli (Homa & Viera, 1988, Experiment 2; Pezdek & Chen, 1982; Pezdek, Maki, Valencia-Laver, Whetstone, Stoeckert, & Dougherty, 1988). The literature on recall also contains results of all three types: no differences (Dirks & Neisser, 1977); realistic superior to abstract (Denis, 1976); and abstract superior to realistic (Ritchey, 1982). Clearly, an eventual reconciliation of these conflicting findings will require careful task analyses as well as new ways to quantify the various types of information available from particular picture representations (Levie, 1987).

In summary, then, the present research provided conclusive evidence that referential uncertainty (the number of acceptable alternative names for an object) increases the difficulty of a post-identification phase of naming. In contrast, no conclusive evidence emerged for an effect of stimulus realism (colored photographs vs. uncolored line drawings) on the object identification phase of naming. The experimental paradigms adopted in this research (i.e., comparison of naming and object decision responses to the same stimuli and learning of novel object-name pairings) may be useful in further attempts to localize the effects of various item attributes on naming performance.

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APPENDIX A

Results of Norming Studies

Table A-1 lists various characteristics of the 95 line drawings that met the initial stimulus selection criterion for Experiment 1. These drawings elicited two or fewer naming omissions from a sample of 32 children, 16 from JK and 16 from G1. The information and conventions included in the table are described below under the appropriate column headings.

Item

Identifying numbers for the items (1-95) are based on an alphabetical ordering of the nominally correct names for the 95 pictures.

Source

Line drawings were selected from several sources: 1 - Snodgrass and Vanderwart (1980); 2 - Paivio et al. (1989); and 3 - miscellaneous other sources.

Sample

Naming responses were collected for each item from one of three different samples of children (1, 2, 3). The samples are described in the text.

Naming Response(s)

The first name listed for each item is the nominally correct response, as listed in the source for each picture. This name was usually the most frequent (dominant) naming response given by children but the few exceptions to this generalization are indicated by an asterisk (*). Alternative, acceptable names for each picture (see Accept below) are show in capital letters. Unacceptable names are shown in lowercase. Naming omissions are indicated by "x".

JK, G1, and Total

These columns show, respectively, the number of JK children (16 possible), the number of G1 children (16 possible), and the total number of children (32 possible) that gave each naming response.

Accept

This column presents the number of adult judges (10 possible) that accepted each naming response as a correct alternative name for the pictured object. Names accepted by 6 or more judges were classified as acceptable; others were classified as unacceptable. When the nominally correct response was the only name give for an item, it was assumed to be acceptable to all judges, as indicated by (10).

AgeA

Shown in this column is the mean rating (16 raters) of age of word acquisition on a 5-point scale (1 = early; 5 = late). Words not rated are indicated by --.

Table A-1

Characteristics of Pictures that Met the Initial Selection Criterion

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
1	1	1	AIRPLANE	15	16	31	10	3.25
			PLANE	1	0	1	10	--
2	1	2	ALLIGATOR	9	11	20	10	--
			CROCODILE	4	2	6	10	--
			lizard	0	3	3	2	--
			turtle	1	0	1	0	3.56
			x	2	0	2	-	--
3	1	1	APPLE	16	16	32	(10)	1.50
4	1	1	BALL	15	16	31	10	1.44
			star	1	0	1	1	--
5	1	1	BALLOON	15	16	31	10	2.44
			round	1	0	1	2	--
6	1	1	BANANA	16	16	32	(10)	2.19
7	1	1	BED	16	16	32	(10)	1.44
8	1	3	BELL	15	16	31	10	3.19
			ding	1	0	1	2	--
9	3	3	BIRD	14	15	29	10	1.69
			WOODPECKER	0	1	1	7	--
			duck	1	0	1	0	1.94

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
9(cont.)			pecker	1	0	1	4	--
10	3	1	BLOCK	9	14	23	10	--
			BOX	0	2	2	6	--
			square	4	0	4	3	4.44
			letter	1	0	1	2	--
			ice	1	0	1	0	--
			x	1	0	1	-	--
11	1	1	BOWL	13	15	28	10	2.69
			DISH	2	1	3	10	3.06
			plate	1	0	1	0	--
12	3	2	BOY*	2	7	9	10	--
			PERSON	8	6	14	10	--
			KID	1	1	2	10	--
			LITTLE BOY	0	2	2	9	--
			GUY	1	0	1	10	--
			MAN	1	0	1	6	--
			people	3	0	3	3	--
13	1	3	BREAD	16	15	31	10	2.44
			toast	0	1	1	4	--
14	3	2	BUCKET	7	11	18	10	--
			PAIL	5	5	10	10	--
			cup	1	0	1	1	1.44
			po	1	0	1	1	--
			basket	1	0	1	0	--
			x	1	0	1	-	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
15	1	1	BUS	16	15	31	10	2.19
			SCHOOL BUS	0	1	1	9	--
16	1	1	BUTTERFLY	16	16	32	(10)	3.38
17	1	3	CAKE	15	16	31	10	2.44
			ham	1	0	1	0	--
18	1	2	CANDLE	14	16	30	(10)	4.06
			x	2	0	2	-	--
19	1	1	CAR	16	16	32	(10)	1.25
20	1	1	CARROT	16	15	31	10	2.75
			VEGETABLE	0	1	1	9	--
21	1	1	CHAIR	16	16	32	(10)	2.25
22	1	1	COAT	6	6	12	10	--
			JACKET	6	5	11	8	--
			CLOTHES	2	1	3	8	--
			RAIN JACKET	0	1	1	9	--
			shirt	1	3	4	2	--
			pants	1	0	1	0	2.75
23	1	3	COMB	10	15	25	10	--
			brush	4	1	5	0	--
			hairbrush	1	0	1	0	--
			x	1	0	1	-	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
24	1	1	CORN	15	13	28	10	3.31
			CORN ON COB	0	3	3	10	--
			heart	1	0	1	0	--
25	1	2	COUCH	11	12	23	10	--
			FURNITURE	2	1	3	9	--
			CHESTERFIELD	1	0	1	10	--
			SOFA	0	1	1	10	--
			chair	1	1	2	3	2.25
			bed	0	1	1	2	1.44
			shoe	1	0	1	0	--
26	1	1	CUP	14	16	30	10	1.44
			COFFEE CUP	1	0	1	10	--
			dish	1	0	1	4	3.06
27	1	1	DOG	16	16	32	(10)	1.44
28	2	1	DOLL	12	15	27	10	2.06
			GIRL	2	0	2	7	2.63
			RAGGEDY ANN	1	0	1	10	--
			person	1	1	2	5	--
29	2	3	DOLLAR	6	9	15	10	4.69
			MONEY	9	5	14	10	4.00
			DOLLAR BILL	0	2	2	10	--
			picture	1	0	1	1	--
30	1	1	DRESSER	10	10	20	10	--
			DRAWER	5	3	8	8	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
30(cont.)			cupboard	1	2	3	2	--
			closet	0	1	1	0	--
31	1	3	DUCK	14	16	30	10	1.94
			BIRD	2	0	2	9	1.69
32	1	3	EAR	14	16	30	10	2.44
			food	1	0	1	0	--
			nose	1	0	1	0	--
33	1	1	ELEPHANT	16	16	32	(10)	3.75
34	1	1	EYE	16	16	32	(10)	1.75
35	1	1	FINGER	14	15	29	10	--
			hand	2	1	3	2	2.38
36	1	3	FLOWER	16	16	32	(10)	2.31
37	2	3	FORK	16	15	31	(10)	3.00
			x	0	1	1	-	--
38	1	3	FRYING PAN*	0	1	1	10	--
			PAN	7	9	16	10	--
			pot	7	4	11	4	--
			magnifying	0	1	1	0	--
			plate	1	0	1	0	--
			bowl	0	1	1	0	2.69
			bake	1	0	1	1	--

table continues

Item	Source	Sample	Name(s)	JK	Gl	Total	Accept	AgeA
39	2	3	GHOST	15	16	31	10	--
			PUPPET	1	0	1	9	--
40	1	2	GORILLA*	5	7	12	10	--
			MONKEY	7	8	15	8	--
			KING KONG	1	0	1	10	--
			APE	0	1	1	10	--
			rhino	1	0	1	0	--
			doggie	1	0	1	0	--
			x	1	0	1	-	--
41	1	1	HAMMER	16	16	32	(10)	2.94
42	1	1	HAND	15	16	31	10	2.38
			FINGERS	1	0	1	10	--
43	2	3	HAT**	16	16	32	(10)	1.56
44	1	1	HELICOPTER	13	16	29	10	--
			airplane	3	0	3	1	3.25
45	1	1	HORSE	16	16	32	(10)	2.31
46	3	2	JACKET*	1	1	2	10	--
			COAT	3	6	9	9	--
			CLOTHES	2	2	4	9	--
			shirt	6	7	13	4	--
			sweater	2	0	2	2	--
			suit	1	0	1	1	--
			vest	1	0	1	1	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
47	1	3	KEY	16	16	32	(10)	2.88
48	1	3	KITE	15	16	31	(10)	2.94
			x	1	0	1	-	--
49	3	2	KITTEN*	1	5	6	10	3.25
			CAT	11	9	20	10	1.50
			KITTY	1	2	3	10	--
			KITTY CAT	3	0	3	10	--
50	1	1	KNIFE	16	15	31	9	3.44
			BUTTER KNIFE	0	1	1	9	--
51	2	2	LADDER	16	15	31	10	3.56
			climber	0	1	1	1	--
52	1	1	LAMP	13	14	27	10	3.94
			LIGHT	2	2	4	10	2.00
			plant	1	0	1	0	--
53	1	3	LEAF	15	16	31	10	3.38
			feather	1	0	1	0	--
54	1	1	LEG	8	11	19	10	2.31
			FOOT	8	5	13	7	2.13
55	2	2	LETTER	8	7	15	10	--
			MAIL	3	2	5	10	--
			ENVELOPE	2	2	4	10	--
			CARD	0	2	2	7	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
55(cont.)			POST LETTER	0	1	1	8	--
			POST CARD	0	1	1	8	--
			note	0	1	1	3	--
			picture	1	0	1	0	--
			x	2	0	2	-	--
56	1	1	LIPS	8	15	23	10	3.50
			MOUTH	6	0	6	10	2.25
			SMILE	0	1	1	8	--
			lipstick	1	0	1	2	--
			x	1	0	1	-	--
57	2	3	LOG	5	10	15	10	--
			WOOD	6	4	10	9	--
			PIECE OF WOOD	0	1	1	10	--
			tree	1	0	1	2	2.13
			hive	0	1	1	0	--
			brick	1	0	1	0	--
			branch	1	0	1	3	--
			carrot	1	0	1	0	2.75
			x	1	0	1	-	--
58	1	1	MOTORCYCLE	12	10	22	10	4.44
			MOTORBIKE	2	6	8	10	4.69
			BIKE	1	0	1	8	2.50
			bicycle	1	0	1	0	4.25
59	1	2	MOUSE	15	13	28	10	3.06
			RAT	0	2	2	10	4.31

table continues

Item	Source	Sample	Name(s)	JK	Gl	Total	Accept	AgeA
59(cont.)			mice	0	1	1	3	--
			x	1	0	1	-	--
60	2	3	MUG*	0	1	1	10	--
			CUP	13	15	28	10	1.44
			drink	1	0	1	5	--
			teapot	1	0	1	1	--
			pot	1	0	1	1	--
61	1	1	MUSHROOM	13	16	29	10	4.75
			SMURFHOUSE	1	0	1	6	--
			mushthing	1	0	1	3	--
			mouse	1	0	1	0	3.06
62	1	2	NECKLACE	13	15	28	10	4.44
			JEWELRY	2	0	2	10	4.88
			jewel	0	1	1	4	--
			reindeer thing	1	0	1	1	--
63	2	1	PAINTBRUSH	13	11	24	10	--
			BRUSH	1	3	4	9	--
			paint	0	2	2	0	--
			painter	2	0	2	1	--
64	1	1	PANTS	15	14	29	10	2.75
			JEANS	0	1	1	10	4.13
			BLUE JEANS	0	1	1	10	--
			TROUSERS	1	0	1	10	--
65	1	1	PIANO	16	16	32	(10)	4.13

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
66	1	1	PIG	15	16	31	10	2.06
			rhinoceros	1	0	1	0	--
67	1	1	POT	8	11	19	10	--
			PAN	3	4	7	7	--
			SAUCE PAN	1	0	1	10	--
			cup	2	1	3	1	1.44
			frying pan	1	0	1	0	--
			pail	1	0	1	0	--
68	3	2	PRESENT	16	15	31	10	3.50
			GIFT	0	1	1	10	--
69	1	2	PURSE	12	13	25	10	3.50
			BAG	0	3	3	10	2.94
			KNAPSACK	1	0	1	6	--
			MAILBAG	1	0	1	9	--
			present	1	0	1	1	3.50
			x	1	0	1	-	--
70	1	2	RABBIT	7	7	14	10	3.69
			BUNNY	3	7	10	10	1.75
			BUNNY RABBIT	5	2	7	10	--
			x	1	0	1	-	--
71	1	3	RING	12	15	27	10	--
			earring	1	1	2	0	--
			snowman	1	0	1	0	--
			hiccups	1	0	1	0	--
			bracelet	1	0	1	2	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
72	2	1	SAILBOAT*	5	9	14	10	4.19
			BOAT	11	7	18	10	2.06
73	1	2	SCISSORS	16	16	32	(10)	3.81
74	3	2	SHIP*	0	3	3	10	4.31
			BOAT	16	13	29	10	2.06
75	2	1	SHORTS	14	16	30	10	4.13
			PANTS	2	0	2	7	2.75
76	3	2	SHOVEL	15	16	31	(10)	3.38
			x	1	0	1	-	3.56
77	1	3	SNAKE	15	16	31	10	3.56
			worm	1	0	1	0	--
78	1	1	SOCK	15	16	31	10	2.06
			foot	1	0	1	2	2.13
79	2	3	SQUARE	16	16	32	(10)	4.44
80	1	1	STOOL	6	9	15	10	4.63
			CHAIR	6	7	13	7	2.25
			SEAT	1	0	1	10	--
			FOOTSTAND	1	0	1	8	--
			wheelchair	1	0	1	0	--
			table	1	0	1	1	--
81	1	2	STOVE	10	12	22	10	3.81

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
81(cont.)			OVEN	5	4	9	10	4.19
			piano	1	0	1	0	4.13
82	1	1	TABLE	14	15	29	10	--
			stool	1	0	1	2	4.63
			chair	0	1	1	0	2.25
			box	1	0	1	0	--
83	3	1	TEDDYBEAR	9	8	17	10	2.56
			BEAR	7	8	15	10	2.31
84	1	3	TELEPHONE	14	11	25	10	3.69
			PHONE	2	5	7	10	2.25
85	1	2	TELEVISION*	1	0	1	10	--
			TV	15	16	31	10	2.31
86	1	1	TIE	13	16	29	10	--
			necklace	1	0	1	0	--
			bow tie	1	0	1	2	--
			jewelry	1	0	1	0	4 88
87	3	2	TIRE*	5	8	13	10	4.19
			WHEEL	11	8	19	10	3.25
88	1	1	TRAIN	12	16	28	10	--
			CHOOCHOO TRAIN	1	0	1	10	--
			truck	1	0	1	0	--
			bus	1	0	1	0	2.19
			x	1	0	1	-	--

table continues

Item	Source	Sample	Name(s)	JK	G1	Total	Accept	AgeA
89	1	3	TREE	16	16	32	(10)	2.13
90	2	1	TRICYCLE*	2	3	5	10	4.50
			BICYCLE	9	5	14	7	4.25
			BIKE	4	6	10	9	2.50
			3 WHEEL BIKE	1	1	2	10	--
			triangle	0	1	1	0	--
91	1	2	TRUCK	13	12	25	10	--
			VEHICLE	0	1	1	9	--
			FURNITURE TRUCK	0	1	1	10	--
			bus	3	2	5	1	2.19
92	1	2	TURTLE	15	15	30	10	3.56
			alligator	1	0	1	0	--
			x	0	1	1	-	--
93	1	2	UMBRELLA	16	16	32	(10)	4.25
94	1	3	WAGON	15	13	28	10	--
			TOY	1	0	1	9	--
			sled	0	1	1	0	--
			stroller	0	1	1	1	--
			x	0	1	1	-	--
95	1	3	WATCH	15	16	31	10	3.81
			belt	1	0	1	0	--

Note. **nominally correct response (cap) was not used.

APPENDIX B

Instructions for Name Acceptability Judgments and

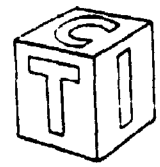
Sample Page from Judgment Booklet

Names for Pictures

A specific picture may elicit several acceptable alternative names. On the following pages, you will see pictures of common objects. Each picture is accompanied by a list of words/phrases that young children used as names for the object. Your task is to indicate whether or not each word/phrase is an acceptable name for the pictured object. An object may have any number of acceptable names. An acceptable name need not necessarily be the "best" (i.e., most frequently used or most specific) name for the pictured object. Two guidelines may help you in making your judgments. If you can imagine a context in which the name could be used to refer to the pictured object, then judge the name as acceptable. If the name clearly indicates that the object has been misidentified/ misperceived, then judge the name as unacceptable. Please record a judgment ("Y" for acceptable; "N" for unacceptable) in the blank provided for each word/phrase associated with each picture. Before beginning your judgments, skim through the lists to get an idea of the types of pictures/names you will be judging. When you have finished your judgments, please check to make sure that you have completed all of the items. Thank you for your help.

____ seat
____ footstand
____ stool
____ chair
____ wheelchair
____ table

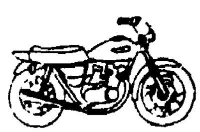
____ box
____ letter
____ block
____ ice
____ square



____ coffee cup
____ dish
____ cup

____ ball
____ star

____ motorbike
____ motorcycle
____ bicycle
____ bike



____ necklace
____ bow tie
____ tie
____ jewelry

____ rhinoceros
____ pig

____ leg
____ foot

APPENDIX C

Age of Word Acquisition Rating Instructions

In this study, your task is to rate (on a 5-point scale) the relative age at which an average child acquires each of a number of names for familiar objects. Acquisition means that the child actually produces the word correctly in his/her speech, although he or she probably comprehended the meaning and recognized the appropriate use of the word at an earlier age. All of the words on the list are acquired relatively early in life, therefore, please make your ratings only with reference to the other words listed here. For example, if a word is one of the earliest-acquired words on the list, it should be given a rating of 1. If a word is one of the latest-acquired words on the list, it should be given a rating of 5. Words that fall between these extremes should be rated accordingly. Please make an effort to use the entire range of numbers from 1 to 5; at the same time, use particular numbers as often as you wish if the numbers reflect your true judgments about the relative age at which each word is acquired.

The words are presented on the following 4 pages with spaces for your ratings. Some words may have more than one meaning. Make your rating for the noun sense of these ambiguous words. Before you begin your actual ratings, look over the list of words to get an indication of the range of variation among the words. Make your ratings carefully, but work fairly quickly without thinking too long about each item. Make a rating for every word. When you have finished your ratings, please double check to make sure that you have rated all the items. Thank you for your help.

APPENDIX D

Letter of Information and Parental Consent Form for Experiment 1

Department of Psychology
University of Western Ontario
London, Ontario N6A 5C2
May, 1989

Dear Parent or Guardian:

I would like permission for your child to participate in a research project that I am conducting at your child's school. The study has been approved by the Board of Education and involves picture naming and picture judging tasks that children find enjoyable. The results are for research use and information about your child will be kept private. The study takes 40 to 60 minutes to complete (two sessions of 20-30 minutes each) and is described fully below. Please complete and return the attached permission form if you are willing to allow your child to participate.

If you have any questions, please call Carla Johnson at 679-2111, Ext. 4726 (days) or 666-1108 (evenings and weekends). Thank you for your cooperation.

Components of Naming in Children

Naming a picture of a familiar object requires at least three mental steps: a) identifying the object, b) selecting an appropriate name, and c) preparing to say the name. Certain characteristics of the picture and its name(s) may make these steps easier (faster, more accurate). For example, a realistic picture (colored photograph) may be easier to identify than a line drawing of the same object. Name selection may be easier for objects with a single well-known name (e.g., elephant) than for those with two or more acceptable names (e.g., lamp/light). In this study, children of different ages will name or identify photographs and line drawings of objects that have one or more acceptable names. Naming should be faster for photographs than for line drawings, and for objects with one name than for objects with several names. In addition, object identification and name selection may become faster as children increase their vocabulary knowledge.

Each child will be tested in two sessions (20-30 minutes each) on separate days. In the first session, children will see slides of: a) 40 familiar objects with a single common name (e.g., elephant) or more than one possible name (e.g., lamp/light) and b) 20 nonobjects (unfamiliar objects made from parts of real objects). Half of the children will name each real object and say "no" to each nonobject. The other half will judge whether each slide shows a real object ("yes" response) or not ("no" response). Each child will complete the naming or judging task twice, once for colored photographs and once for line drawings of the same objects. Responses and response times will be recorded. In the second session, each child will learn nonsense names (one or two) for four novel objects. The child will then name line drawings and photographs of the novel objects. Responses and response times will be recorded. Finally, each child will be given a test of vocabulary knowledge, the Peabody Picture Vocabulary Test. In this test, the child points to a picture (from a choice of four) that matches a word spoken by the tester.

The results of this study should help us understand how children develop the ability to name objects. I will inform parents about the results and will eventually publish them in a journal so that others may benefit from my findings.

Components of Naming in Children

Consent Form

Child's Name: ______________________________ Grade: ________

Child's Date of Birth: ______________________

Is English the primary language spoken in your home? Yes ____ No _____

_______ I agree to allow my child to participate in "Components of Naming in Children"

_______ I do not wish my child to participate in "Components of Naming in Children"

______________________________ ______________________

(Signature of Parent or Guardian) (Date)

APPENDIX E

Experiment 1 Instructions

Naming Condition

Today we're going to look at some pictures. Some of the pictures will show real things, things that you know. You see these real things all the time at home, at school, on tv, or in books. Let me show you some real things. A pencil is a real thing. You see pencils at school, at home, on tv, and in books. A cup is a real thing that you see in books, on tv, at home or maybe even at school. Some other pictures will show new, make-believe things that you have not seen before. These new, make-believe things are made from pieces of other things. Let me show you some new things that I made up. These things are not real, they're just make-believe. Here's a new, make-believe thing. You've never seen it before. I just made it up from parts of other things (show 1st demonstration nonobject). Here's another new, make-believe thing. You never saw this thing before either (show 2nd demonstration nonobject) because its just make-believe. I made it from parts of other things.

Now I'm going to show you pictures of real things and of new, make-believe things, all mixed together. When you see a real thing that you've seen before, tell me its name as fast as you can. When you see a new, make-believe thing that you've never seen before, say "no" as fast as you can. Remember, for a real thing, say its name. For a new, make-believe thing, say "no". Let's try some now for practice.

Feedback as appropriate, e.g., (a) real thing named - "Good, you told me the name of this real thing" (b) real thing not named - "This one is a real thing. You've seen it before. What is it?" (c) nonobject "no" - "Good, you said 'no' for this new, make-believe thing because you never saw it before." (d) nonobject not "no" - "This one is a new, make-believe thing. You never saw it before. Say 'no' for it."

Now I'm going to show you some mor pictures of real things and new, make-believe things. For a real thing, say its name as fast as you can. For a new, make-believe thing, say "no" as fast as you can. Ready?

After each block, encourage effort and remind child of task.

After first stimulus type has been presented:

You did a good job with those (colored, black and white) pictures (whichever was 1st for child). Now I want you to do the same thing with (black and white, colored) pictures (whichever is 2nd for child). Remember, for a real thing, say its name as fast as you can. For a new, make-believe thing, say "no" as fast as you can. Let's do some for practice.

Practice with feedback and stimulus presentation as above.

<u>Object Decision Condition</u>

Today we're going to look at some pictures. Some of the pictures will show real things, things that you know. You see these real things all the time at home, at school, on tv, or in books. Let me show you some real things. A pencil is a real thing. You see pencils at school, at home, on tv, and in books. A cup is a real thing that you see in books, on tv, at home or maybe even at school. Some other pictures will show new, make-believe things that you have not seen before. These new, make-believe things are made from pieces of other things. Let me show you some new th' .gs that I made up. These things are not real, they're just make-believe. Here's a new, make-believe thing. You've never seen it before. I just made it up from parts of other things (show 1st demonstration nonobject). Here's another new, make-believe thing. You never saw this thing before either (show 2nd demonstration nonobject) because its just make-believe. I made it from parts of other things.

Now I'm going to show you pictures of real things and of new, make-believe things, all mixed together. When you see a real thing that you've seen before, say "yes" as fast as you can. When you see a new, make-believe thing that you've never seen before, say "no" as fast as you can. Remember, for a real thing, say "yes". For a new, make-believe thing, say "no". Let's try some now for practice.

Feedback as appropriate, e.g., (a) real thing "yes" - "Good, you said "yes" for this real thing." (b) real thing not "yes" - "This one is a real thing. You have seen it before. Say 'yes' for it." (c) nonobject "no" - "Good, you said 'no' for this new, make-believe thing because you never saw it before." (d) nonobject not "no" - "This one is a new, make-believe thing. You never saw it before. Say 'no' for it." (If necessary, specifically discourage use of names for real objects).

Now I'm going to show you some more pictures of real things and new, make-believe things. For a real thing. say "yes" as fast as you can. For a new, make-believe thing, say "no" as fast as you can. Ready?

After each block, encourage effort and remind child of task.

After first stimulus type has been presented:

You did a good job with those (colored, black and white) pictures (whichever was 1st for child). Now I want you to do the same thing with (black and white, colored) pictures (whichever is 2nd for child). Remember, for a real thing, say "yes" as fast as you can. For a new, make-believe thing, say "no" as fast as you can. Let's do some for practice.

Practice with feedback and stimulus presentation as above.

APPENDIX F

Letter of Information and Parental Consent Form

for Experiments 2 and 3

Department of Psychology
University of Western Ontario
London, Ontario N6A 5C2
January, 1990

Dear Parent or Guardian:

I would like permission for your child to participate in a research project that I am conducting at your child's school. The project has been approved by the Board of Education. The study involves picture naming tasks that children find enjoyable. The results are for research use and information about your child will be kept private. The study takes 25 to 30 minutes to complete and is described fully below. Please complete and return the attached permission form if you are willing to allow your child to participate.

If you have any questions, please call Carla Johnson at 679-2111, Ext. 4726 (days) or 666-1108 (evenings and weekends). Thank you for your cooperation.

Components of Naming in Children

Naming a picture of a familiar object requires at least three mental steps: a) identifying the object, b) selecting an appropriate name, and c) preparing to say the name. Certain characteristics of the picture and its name(s) may make these steps easier (faster, more accurate). For example, a realistic picture (colored photograph) may be easier to identify than a line drawing of the same object. Name selection may be easier for objects with a single well-known name (e.g., elephant) than for those with two or more acceptable names (e.g., lamp/light). In this study, children will name photographs and line drawings of objects that have one or more acceptable names. Naming should be faster for photographs than for line drawings, and for objects with one name than for objects with several names. In addition, naming may become faster as children increase their vocabulary knowledge.

Each child will complete three tasks. In the first activity, children will name slides of 20 familiar objects with a single common name (e.g., elephant) and 20 objects with more than one possible name (e.g., lamp/light). Each child will name the objects twice, once as colored photographs and once as line drawings. Responses and response times will be recorded. In the second task, each child will learn nonsense names (one or two) for two novel objects. The child will then name line drawings and photographs of the novel objects. Responses and response times will be recorded. Third, each child will be given a test of vocabulary knowledge, the Peabody Picture Vocabulary Test. In this test, the child points to a picture (from a choice of four) that matches a word spoken by the tester.

The results of this study should help us understand how children develop the ability to name objects. I will inform parents about the results and will eventually publish them in a journal so that others may benefit from my findings.

Components of Naming in Children

Consent Form

Child's Name: ______________________________ Grade: ________

Child's Date of Birth: ______________________

Is English the primary language spoken in your home? Yes ____ No ____

______ I agree to allow my child to participate in "Components of Naming in Children"

______ I do not wish my child to participate in "Components of Naming in Children"

______________________________________ ________________________

(Signature of Parent or Guardian) (Date)

APPENDIX G

Experiment 2 Instructions and Sample Presentation Form

In this next activity, I'd like you to learn the names for two new things. One thing has only one name and the other one has two names. First, I'll tell you the names. Then you'll have a chance to practice saying the names and remembering them. After you have practiced and learned the names, I'll show you some slides of the new things for you to name all by yourself. So, remember, try your best to learn the names.

For comprehension:

Now I'm going to say a name and I want you to point to the right thing.

For production:

Now I'd like you to say the names for these things by yourself. (For two-name object) What's one name for this thing? What's its other name?

After production criterion met:

Good, I think you know the names. Now I'm going to show you pictures of these new things and of some other things that you know. I want you to say a name for each pictures as fast as you can. For the new thing that has two names, you only need to say one of them. Let's try a few pictures for practice. (1st practice set)

Good. Now in this group, you'll see pictures of the new things. For each picture, say one name for it as fast as you can. (Then 2nd practice set and 2nd test set)

Experiment 2 Sample Presentation Form

Presentation Order 1

NO 1 (green) hi: This thing has two names. It is called a koobit or a magger. A magger or koobit is made of plastic. Remember this is a koobit or magger. You say its names after me "magger" (child imitates) "koobit" (child imitates).

NO 2 (silvr) lo: This new thing has only one name. It is called a fiffin. A fiffin is made of metal. Remember that this new thing is called a fiffin. You say its name after me "fiffin" (child imitates).

Imitation = 1 (koobit, magger), 2 (fiffin)

Imitation = 2 (fiffin), 1 (magger, koobit)

Comprehension Test 1
magger (1) kocbit (1) fiffin (2)
Feedback "Good, that is (name)." or "No, this is (name)." (point)

Imitation = 2 (fiffin), 1 (koobit, magger)

Comprehension Test 2 - "try to remember the names because I'll ask you to say them by yourself after this."
koobit (1) fiffin (2) magger (1)
Feedback "Good, that is (name)." or "No, this is (name)." (point)

Production #1	Production #2	Production #3	Production #4
0 ball	0 pencil	1 koobit	0 cup
0 pencil	2 fiffin	magger	0 ball
1 koobit	1 koobit	0 cup	0 pencil
magger	magger	2 fiffin	2 fiffin
0 cup	0 cup	0 ball	1 koobit
2 fiffin	0 ball	0 pencil	magger

Feedback "Good, that is (name)." or "No, this is (name)." (point)

Test Order [P]	Test Order [L]
L hammer	R airplane
R flower	L 1 koobit magger
R 2 fiffin	R horse
L airplane	L flower
R 1 koobit magger	R hammer
L horse	L 2 fiffin
L 1 koobit magger	R flower
R hammer	L airplane
R horse	R 2 fiffin
L 2 fiffin	R 1 koobit magger
R airplane	L hammer
L flower	L horse